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AEROSOL RESEARCH FACILITY: OPERATION AND COMMISSIONING

Report No. 91-74-K
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ABSTRACT

The Aerosol Research Facility was constructed and commissioned in 1990. In this report, comprehensive information on the operation of the Aerosol Research Facility is given. This information is aimed at getting one started with the facility as quickly as possible. The commissioning tests demonstrated that the facility is capable of providing velocity ranging from 2 to about 20 m/s, and maximum aerosol concentration of about 60,000 particles/cm^3 at a velocity of about 2.5 m/s. With the use of honeycomb and wire screens, the variation in airspeed across the tunnel has been reduced to within about $\pm$ 10% ; the corresponding temporal variation was within about $\pm$1%. With the use of the mixing orifice, the variation of the aerosol concentration was found to be within $\pm$ 8%. The facility is ready to be used in the many research and test programs for which it was designed. Some of these have already been started.

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To: Dr. D. Mills
Director of Research

AEROSOL RESEARCH FACILITY: OPERATION AND COMMISSIONING

1.0 INTRODUCTION

1.1 Background

The conception of a multi-purpose aerosol research facility took place in 1987 in response to a recommendation from the Research Division's Environmental Program Champion Task Group that the Division develop expertise in aerosol science [1,2]. Based on discussions within the Research Division and with various stakeholders elsewhere within Ontario Hydro, it became clear that this facility would be a valuable asset to the Corporation. The Environmental Science Section was responsible for the design, construction and operation of the facility, while other potential users such as the Process Chemistry and Mechanical Testing and Development Sections would have access to the facility for their own work programs.

In 1988, an Ontario Hydro Research report entitled "Design of a Multipurpose Aerosol Research Facility" was published [3], which gave detailed information on the design criteria, specifications for each component, instrumentation and cost estimates. In simple terms, the aerosol research facility consists of a tunnel with the capability of generating large-scale air flows of well-defined properties such as flow velocity, temperature and relative humidity, containing well-characterized aerosols. It was designed to be built in three stages. The first stage was an open circuit tunnel operating under ambient conditions, while the second and third stages were closed-circuit tunnels capable of operating at elevated or reduced temperature and humidity.

Construction of the first stage aerosol research facility began with site preparation in April 1989 and was completed with installation of the tunnel in March 1990. The facility is located in Building KT, KT125, a room about 18 feet wide and 45 feet long (Figure 1). The room was divided into two areas - a main test area and the fan room. In addition to the tunnel, the facility includes a deionized water system (Biolab model 360C mixed bed deionization system), a filtered air system (Balston Type 75-20), and an external exhaust air system.

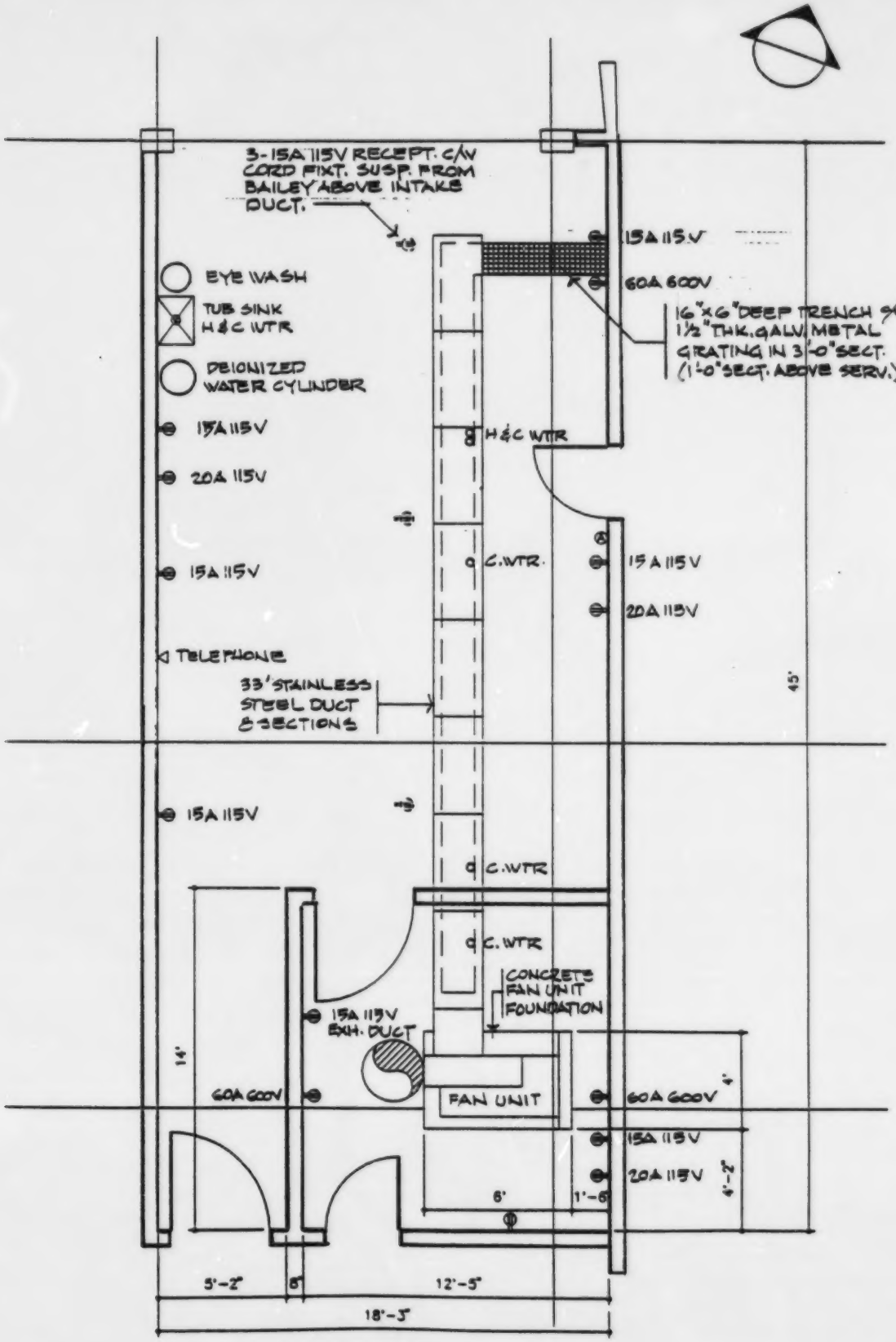


Figure 1. KT 125 Floor Plan

Commissioning began in April 1990 and was completed in September 1990. During this period, equipment was calibrated and installed inside the tunnel, and a data acquisition system was set up for the humidity, pressure, temperature and velocity sensors. A test program was carried out to determine the most relevant aerodynamic properties of the tunnel, to assess the level of aerosol concentration within the tunnel, and to measure the noise level within the facility.

1.2 Purposes of the Report

The purposes of this report are: (1) to provide information on the operation of the aerosol research facility and; (2) to present results of the commissioning tests.

For those who are unfamiliar with the facility, it is recommended that they read Sections 1.0 and 2.0 for a general overview of the facility, and then become familiar with the layout in KT125. Section 3.0 will get them started on the operation of the tunnel. In particular, Section 3.1, "Quick Start", will be helpful since it outlines the steps needed to operate the tunnel. For those who are familiar with the facility, this report serves as a reference or guide. For those who are interested in the capability of the facility, Section 5.0 on the commissioning tests gives the range of operating conditions, and uniformity of velocity and aerosol concentrations across the tunnel.

2.0 GENERAL DESCRIPTION

Detailed information on the design of the tunnel was given in the previous Ontario Hydro Research report [3], and additional information is stored in five binders labelled "Aerosol Research Facility (1)-(5)", kept in the Environmental Science Section. A list of contact persons is given in Appendix I.

2.1 Tunnel

Figure 2 shows the schematic diagram of the tunnel. Pictures of the tunnel are shown in Figure 3. The tunnel is a low speed wind tunnel with the capability of generating well characterized aerosols. The test duct was constructed in a modular fashion with the following functional units - bellmouth, inlet filter housing, aerosol injector, mixing orifice, turbulence reducers, upstream and downstream sampling sections, test section or test filter housing. Each unit is interchangeable or removable. The test duct is about 34 feet long and supported on movable trolleys. The tunnel is constructed of 3.5 mm thick (gauge 10) type 316 stainless steel. The tunnel is designed to withstand the following conditions:

Static pressure: $\geq$ 5 kPa (20 in. water gauge)
Velocity: 20 m/s (3940 fpm)
Temperature: -30°C up to about 100°C
Relative Humidity: up to about 100%

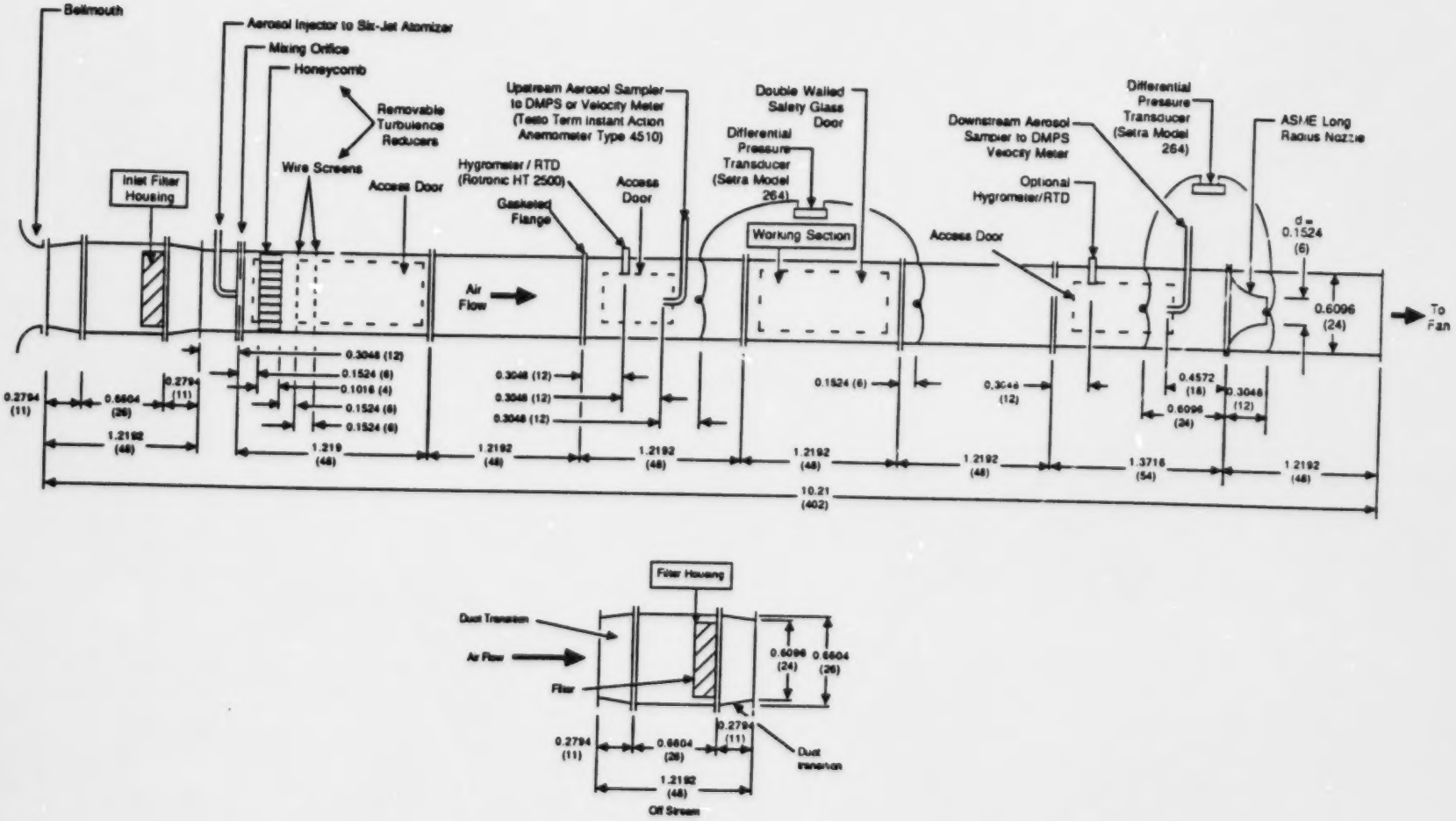
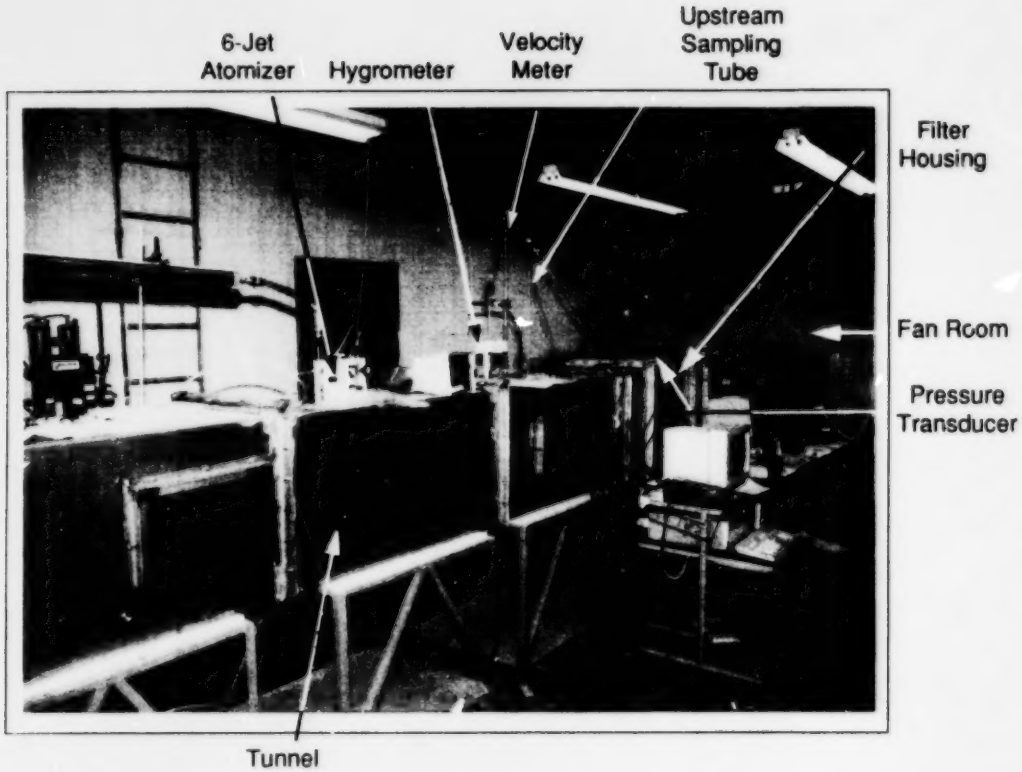


FIGURE 2

FIRST STAGE TUNNEL SHOWING INTERCHANGEABLE TEST SECTIONS (WORKING SECTION AND FILTER HOUSING) (DIMENSIONS: METER (INCH))



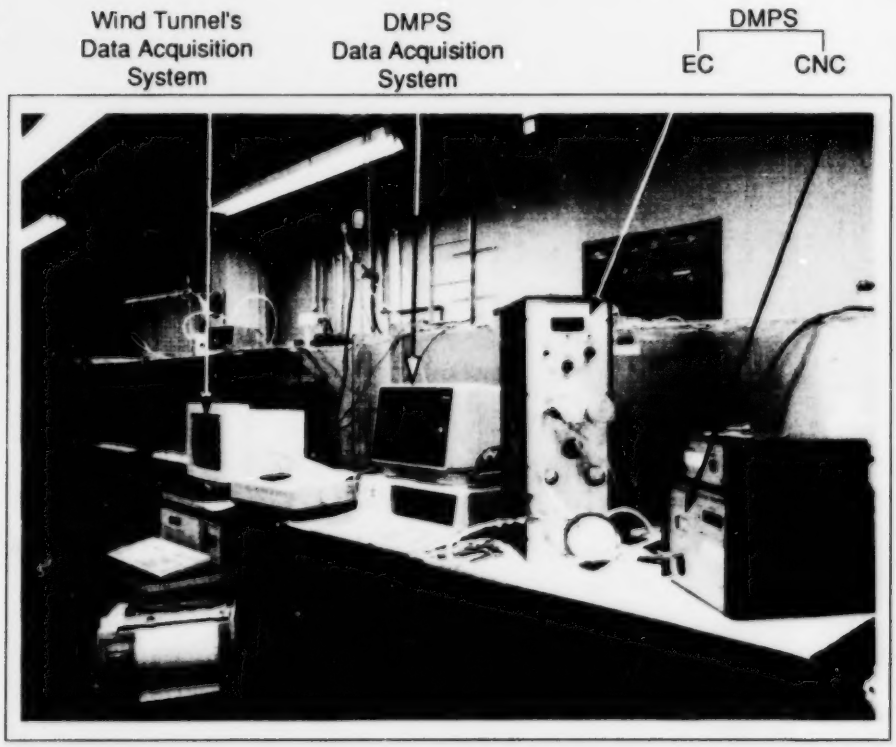


FIGURE 3

PICTURES SHOWING THE AEROSOL RESEARCH FACILITY AT KT 125

The drive system consists of a centrifugal fan (Canadian Blower type BL fan, rated at 10000 CFM and fan R.P.M. 3081), a motor (type ODP, 30 H.P.), a variable inlet vane and an outlet damper control. The performance curve and other relevant information about the fan are given in Appendix II.

In order to minimize transmission of vibration from the fan assembly to the concrete floor, the fan was supported on a concrete block mounted on four isolating pads (30 durometer type R rubber). Furthermore, in order to isolate the fan noise from the KT125 work area and other building facilities, the fan room was constructed using 200 mm block wall with a sealed metal deck ceiling. An acoustic absorptive material was also installed on the ceiling.

2.2 Instrumentation

Figure 2 shows the instrumentation used in the tunnel. It consists of a hygrometer (Rotronic HT250D), velocity meter (Testoterm Instant Action Anemometer type 4510), differential pressure transducer (Setra model 264 pressure transducer). Instrument manuals are given in Appendix III. For submicrometer particles, the equipment consists of an atomizer (TSI 6 jet atomizer model 9306), and a particle analyzer (TSI Differential Mobility Particle Sizer (DMPS)). The DMPS has three main components - the Electrostatic Classifier (EC), the Condensation Nucleus Counter (CNC) and an IBM PC-XT for automated operation, data reduction and recording (Figures 3 and 4).

The humidity, temperature, pressure drop and velocity data are stored on a PC-AT system via a Metrabyte DASH16F A/D board and LabTech Notebook software.

3.0 OPERATING PROCEDURE

Before operating the tunnel, one needs to become familiar with the layout of the facility in KT125. Section 3.1 gets you started on the operation. Section 3.2 and 3.3 will give further details of the operation of the DMPS and the wind tunnel's data acquisition system.

3.1 Quick Start

3.1.1 Starting Procedure

1) Turn on the following equipment and computer systems:

DMPS: EC, CNC, CNC pump, DMPS interface board, PC-XT computer, Roland PR 1012 printer, DMPS pump (Thomas model 8850)

WIND TUNNEL (WT): PC-AT computer, Epson LQ510 printer, IUOR power supply to the pressure transducers, Analog Device power supply to the amplifier and hygrometer, velocity meter.

2) Align printer paper in both printers.

3) Press any key on both computers.

4) On DMPS computer, select **DMPS CNC** by typing "**2**"

5) On DMPS computer, select **RUN PARAMETER** by typing "**2**".

6) Set DMPS **RUN PARAMETERS** to:

Measure Mode to every 4th channel or every channel
No. of Samples to 1 or any desired number
Toggle on 5,6,7,C,F or other desired features
Type **<D>**, type in the desired heading and press **<ret>**
Type **<E>**, type in the desired file name for storage and press <ret>
Type **<esc>** to return to the previous menu

7) On the WT computer, press:

Select **SETUP**, press **<ret>**
Select **SAVE/RECALL**, press **<ret>**
Select **RECALL**, press **<ret>**
Type "**HEPA3**" **<ret>**
Type **<esc>** to return to the previous menu
Select **Files**
Change **Data File Name** to the desired file name with .PRN extension for LOTUS
Change **Header Lines** if desired
Type **<esc>** twice to return to the main menu

8) Position the upstream and downstream sampling tubes, and velocity probe to desired locations. Record the positions.

9) Set the fan variable inlet vane and outlet damper control to the desired setting. Record both settings.

10) Turn on the fan by releasing the main electric supply to the fan and pressing the green button in the fan room.

11) Adjust the flows in the DMPS by turning the **Meter Selection** on the EC and setting the meter reading for the Excess Air, Sheath Air and Monodisperse Air as follows:

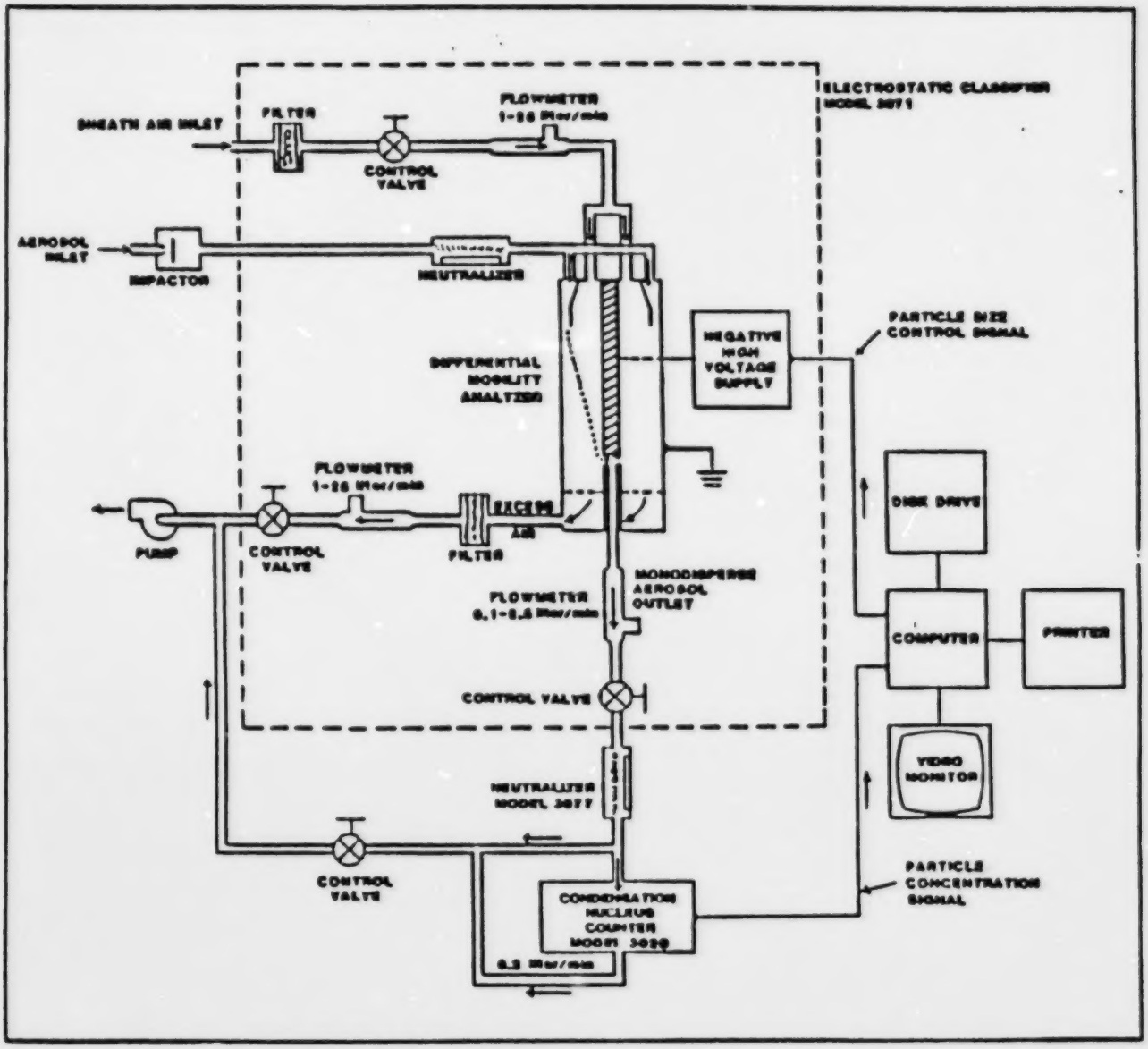


Figure 4. Differential Mobility Particle Sizer

Excess Air to 2.64 V
Sheath Air to 2.51 V
Monodisperse Air to 1.965 -1.975 V
Pressure drop across the impactor to about 2.5 inch water gauge
CNC flow to zero position

12) Turn on compressed filtered air and set main pressure gauge to about 60 psig.

13) Turn on the 6 jets, and adjust atomizer pressure to about 40-60 psig (maximum pressure about 60 psig) and Tylan flow meter to about 300-500. Record atomizer pressure and flow meter reading.

14) Run the DMPS and WT program simultaneously by pressing "**1**" on the DMPS and select **RUN** in the WT.

15) Repeat steps 4-14 if required for another run.

3.1.2 Stopping Procedure

1) Turn off the fan by pressing the red button and shutting off the main electric supply to the fan in the fan room.

2) Turn off the equipment and computer systems.

3) Shut off the compressed air supply to the 6 jet atomizer.

3.2 Differential Mobility Particle Analyzer (DMPS)

Relevant information about the DMPS is highlighted here for quick reference. For further information consult the DMPS manual [4-8]. Sections 3.2.1 and 3.2.2 involve setup of the DMPS and data acquisition system, and Sections 3.2.3, 3.2.4 and 3.2.5 provide detailed information on the operation of the DMPS.

3.2.1 DMPS Computer Setup

An IBM PC/XT system is used in conjunction with the interface board to control and acquire the DMPS data. They are set up as follows:

1) Connect the parallel printer interface cable to the printer.

2) Connect the DMPS interface cable to the a synchronous communication adaptor (RS232) and the DMPS interface box.

3.2.2 DMPS/C Underpressure Mode

The DMPS is setup in the underpressure mode since the pressure inside the tunnel is slightly below atmospheric. Hence, the aerosols to be measured must be drawn through the sampling tube into the instrument by a vacuum source. Figure 5 shows the plumbing associated with the DMPS/C in the underpressure mode.

3.2.3 Operation of the DMPS/C

1) Turn on the power to the CNC. After a few minutes check that the alcohol has filled the reservoir and that the indicator lights are reading properly. The heater light (yellow light) should cycle on and off. The condenser light and alcohol level light should be on (green light) continuously. Allow the CNC a full 20 minutes warm-up before taking data.

2) Connect one of the 6-ft cables to the interface connector. Connect the black wire to the Ground and the red wire to the External Program input of the EC. (The electrical strip is on the back panel of the EC.) Connect the other end of the cable to the **ANALYZER VOLTAGE** jack on the DMPS interface.

3) Switch the Analyzer voltage toggle switch to **EXTERNAL PROGRAM** on the front panel of the EC.

4) Connect the remaining three 6-ft. cables as follows:

DMPS Interface Output Jack	CNC Output Jack
MANTISSA	Conc. A (Mantissa)
EXPONENT	Conc. B (Exponent)
COUNT	Counter Trigger

5) Set the CNC averaging time switch to SHORT. Set the range switch to AUTO.

6) Turn on power to the EC.

7) Choose flowrates for the EC such that the ratio of Sheath Air to Aerosol is 10:1. The excess air must equal the sheath air. The diameter measuring ranges for various flowrates are shown in Table 1. The flowmeter calibration curves are included in Appendix IV. Since the flowrate of the CNC is 0.3 L/min, it is necessary to choose an aerosol flowrate at or above 0.3 L/min and to select a 0.0508 cm nozzle impactor.

8) Set the flows corresponding to underpressure mode.

   For this operation, the electrostatic classifier flowrates are set as follows:

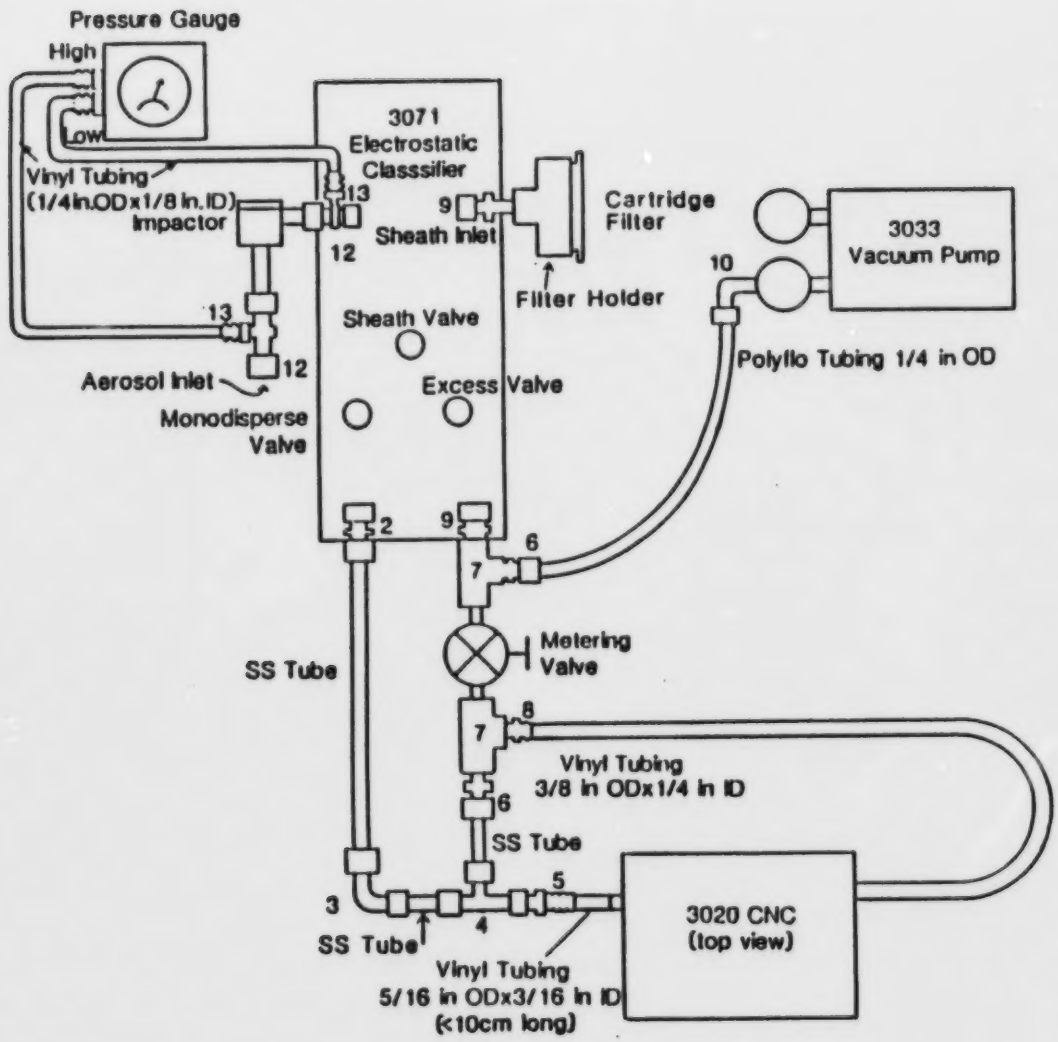


Figure 5. Plumbing Associated with the DMPS/C in the Underpressure Mode

	Flows (L/Min)	Corresponding Voltage/Meter Readings
Sheath Air:	3	2.51 V
Aerosol Air:	0.3	6.5 cm H_2O (2.6 in.)
Excess Air:	3	2.64 V
Monodisperse Aerosol:	0.3	1.965-1.975 V

Table 1. Electrostatic Classifier Flowrates and Range of Measurable Particles Sizes for the DMPS System

Sheath Air (L/min)	Aerosol Air (L/min)	Diameter Range (micrometers)
2.5	0.25	1.056-0.18
3	0.3	0.886-0.017
6	0.6	0.457-0.011
10	1.0	0.337-0.01

3.2.4 Setting Flows in the DMPS/C Underpressure Mode

Adjust the flows as follows (Figure 5):

1) Prior to turning on any pumps adjust the valves as follows:

   Sheath air valve - fully open
   Monodisperse aerosol valve - fully open
   Excess air valve - fully closed
   External metering valve - fully closed

2) Turn on the power to both the large vacuum pump (Thomas model 8850) and the CNC pump.

3) Turn the Meter Selection switch on the EC to the Excess Air flowmeter. Slowly open the Excess Air valve until the desired flowrate is obtained.

4) Turn the Meter Selection switch to the Monodisperse Air flowmeter. Slowly open the external metering valve so that the monodisperse aerosol is at the proper flowrate. Leave the monodisperse aerosol valve inside the EC to the fully open position.

5) Turn the Meter Selection switch to the Sheath Air flowmeter. Adjust the Sheath Air valve to the correct flow.

6) Check to see that the impactor pressure drop agrees with its flow calibration.

7) Repeat steps (3 to 6) until all flowrates are properly set. The CNC pump must be on while setting the flows.

8) Check to see that the CNC flowmeter is reading in the null position.

9) Remove the impactor head screw. Place a light coating of grease on the impaction surface. Replace the lead screw.

10) Perform the final system check as follows:

- Measure the aerosol concentration coming out of the monodisperse aerosol port with zero voltage potential on the centre rod,
- Confirm that no particles measured by the CNC if the system has perfectly laminar flow and is leak tight,
- Recheck and fine tune the system flowrates to eliminate any turbulence,
- Check all fittings and filters for possible leaks,
- Do not make size distribution measurements if the concentration measured by the CNC exceeds a few tenths of a particle/cm^3.

3.2.5 DMPS Software Description

The DMPS software is stored in the PC-XT subdirectory C:\DMPS. The DMPS program runs in basic and requires an IBM PC system with a CGA card. Since the computer system has a monochrome display, the programs SIMCGA AND SETCGA are required to emulate the CGA. These programs are stored in the root directory (C:\). The required programs are listed below:

In the root directory, C:\: AUTOEXEC.BAT, SIMCGA.COM, SETCGA.COM, ASTCLOCK.COM

In the C:\DMPS directory: BASICA.COM, MENU.BAS, SYSTM.BAS, DMPS-CNC.BAS, COUNT.BAS, DMPS.DAT

The Autoexec.bat file is used to run the DMPS program automatically when the computer is booted. The program listing for **AUTOEXEC.BAT** is given below:

```
ECHO OFF
PATH=C:\;C:\DOS;C:\LOTUS
PROMPT $T-$P$G
ASTCLOCK
SIMCGA
SETCGA
CLS
ECHO                *
ECHO                *
ECHO                *
ECHO                *
ECHO                *
ECHO Press Ctrl C to exit ARF run...otherwise any key
ECHO                *
ECHO                *
ECHO                *
ECHO                *
ECHO                *
PAUSE
CD\DMPS
BASICA MENU
ECHO ON
```

Type Ctrl C to get out of the DMPS program, when the computer is booted.

3.2.5.1 Function Keys Used in DMPS

Following is a list of keys used in running the DMPS software:

ESC - the escape key will bring the program back to the last menu shown.

C - causes the cursor to appear on graphs

space bar - causes tabular data displays to stop, once stopped, pressing the space bar a second time will cause the displays to start up again

space bar - causes the counting in the CNC version to stop, read the values and continue on to the next channel

P - prints graphs on printer

T - terminates the sampling after the current run is complete

<Ret> - used to enter data

3.2.5.2 Menu

The following is a list of the menu appearing on the screen:

When turning the DMPS computer on, the following message appears on the screen

1) First Message

*
*
*
*
*

Press Ctrl C to exit ARF run...otherwise any key

*
*
*
*
*

Strike a key when ready

Pressing any key will activate the DMPS software or typing **Ctrl C** will exit the ARF program.

After typing Ctrl C, respond to the question "Terminate batch job (Y/N)?" by typing "**Y**".

2) First Menu

TSI DIFFERENTIAL MOBILITY

PARTICLE SIZER
OPTIONS:

1- DMPS ELECTROMETER
2- DMPS CNC
3- CNC COUNT MODE
4- SYSTEM
5- END

Select **2** for DMPS CNC.

3) Second Menu

TSI DIFFERENTIAL MOBILITY
PARTICLE SIZER
OPTIONS:

1- RUN
2- RUN PARAMETERS
3- TABLE
4 -GRAPHS
5- DISK SAVE
6- DISK RECALL
7- BUFFER SAVE
8- BACKGROUND SUBTRACTION
9- SELECT PRINTER TYPE
0- END PROGRAM

Select **2** for changing parameters or **1** for run. If 2 is selected, the third menu will appear.

4) Third Menu

PARAMETER CHANGE OPTIONS:

1-	FLOW RATE	SHEATH=3	AERO=.3
	DIAMETER	MAX=.886	MIN=.017
2-	MEAS. MODE		EVERY CHANNEL
3-	NO. OF SAMPLES		1
4-	MOBILITY GRAPH		OFF
5-	NUMBER CONC. GRAPH		OFF
6-	SURFACE CONC. GRAPH		OFF
7-	VOLUME CONC. GRAPH		OFF
8-	CUMU. NUMBER GRAPH		OFF
9-	CUMU. SURFACE GRAPH		OFF
A-	CUMU. VOLUME GRAPH		OFF
B-	MOBILITY PRINTOUT		OFF
C-	CONC. AND CUMU.% PRINTOUT		OFF
D-	HEADING		
E-	FILE NAME		
F-	DISK SAVE		OFF
G-	COMPARISON GRAPH		OFF
H-	COMPARISON PRINTOUT		OFF
I-	BACKGROUND SUBTRACTION		OFF
J-	SAMPLE LIMITS	T=30	P=1000

Change **Measure Mode** to every 4th channel or every channel, and no. of samples to 1 or any desired number. Toggle on 5,6,7,C,F or other desired features, and enter the desired heading and file name if needed.

Any time you want to go back to the system, press **<esc>** to go back to the first menu, and select **END** by typing " **5**". The message "**OK**" appears on the screen. Typing "**System** " and **<ret>** will bring you back to the DOS.

3.2.5.3 Common Errors

The most frequent error is a time-out error when running DMPS. The possible reasons are: (1) the interface cable is disconnected; (2) the interface box power is off; and (3) the printer is off when printing is required. Correct the problem and press **<esc>** to continue the program. If this does not help, try rebooting the system. Another frequent error is CNC counts high when the EC voltage is 0. The possible reasons are: (1) unbalanced EC flows; and (2) leaks in the system. Correct the problem by adjusting the flows according to Section 3.2.4 and tightening the tube fittings, especially the one going to the CNC.

3.3 Data Acquisition System

Analog voltage signals from the hygrometer, the two pressure transducers and the velocity meter are converted via a Metrabyte DASH16F interface board and Labtech Notebook software, and stored in the PC-AT computer. The configurations for the interface board and the Labtech Notebook are given below.

3.3.1 Metrabyte Interface Board

For detailed information, refer to Section 2 of the DASH16F operating manual [9].

3.3.1.1 Metrabyte Interface Board Configuration

Before changing the Interface Board setting, turn off the computer.

1) Channel Configuration - Slide the **CHAN CNFG** in the 8 position for 8 differential analog input channels.

2) A/D - Slide the **A/D** switch to bipolar position. In this position, inputs can range from equal negative to positive full scale limits.

3) DMA (Direct Memory Access) - Slide the **DMA** to level 1 for hard disk equipped computer.

4) Gain - Set the gain to bipolar $\pm$ 5V by setting the dipswitch (PC-6102) as follows:

A	B	C	D	USER
ON	OFF	OFF	OFF	OFF

5) BASE ADDRESS
switch - Set the base address to 310 HEX (784 Decimal) as follows:

9	8	7	6	5	4
OFF	OFF	ON	ON	0N	OFF

3.3.1.2 Analog Input Connections

The electric outputs from the instrument are connected to the Metrabyte Interface Board according to Table 2 as follows:

Table 2. Analog Input Connections

Interface Channel	Channel Type	PIN +	PIN -
1	Velocity from Testoterm	36	17
2	Temperature from Testoterm	35	16
3	Temperature from Hygrometer	34	15
4	Humidity from Hygrometer	33	14
5	Differential pressure across filter housing (0-10 in. water)	32	13
6	Differential pressure across the tunnel (0-25 in. water)	31	12

For more information, see Appendix A of the DASH16F operating manual [9].

3.3.2 Labtech Notebook Software Setup

AUTOEXEC.BAT and CONFIG.SYS are stored in C:\, Grafplus software in D:\GRAFPLUS and Labtech Notebook software in D:\NB. The AUTOEXEC.BAT and CONFIG.SYS programs are needed to activate the Labtech Notebook (NB) software when the computer is booted. The GRAFPLUS program is required for PRINT SCREEN function in the NB program. In order to run the NB, a hardware key is required which is placed in the parallel port. The program listings for the **Autoexec.bat** and **Config.sys** are given below:

AUTOEXEC.BAT

```
ECHO OFF
INIT_VDI
PATH=C:\;C:\DOS;D:\NB;D:\WP;D:\123;D:\GRAFPLUS
PROMPT $T-$P$G
GRAFPLUS=14
CLS
ECHO                *
ECHO                *
ECHO                *
ECHO                *
ECHO                *
ECHO Press Ctrl C to exit ARF run... otherwise any key

ECHO                *
ECHO                *
ECHO                *
ECHO                *
ECHO                *
PAUSE
D:
CD\NB
NB
CD\NB
ECHO ON
```

CONFIG.SYS

```
DEVICE=VDIDY010.SYS
DEVICE=VDI.SYS
BREAK=ON
BUFFERS=4
FILES=24
DEVICE=ANSI.SYS
DEVICE=DMDRVR.BIN
```

3.3.2.1 Labtech Notebook Configuration Setup

Table 3 outlines the setup for input/output channels, windows and files. The setup is stored in D:\NB\SETUP\HEPA3. It involves setting the six analog inputs (Table 2) and 1 RS232 input channels. The RS232 input channel is used to trigger off the wind tunnel data acquisition when an initialization string "@" is received. This string is sent by the DMPS computer via serial I/O

ports, when the DMPS run is completed. For more information, consult Chapters 6-8 of the Labtech Notebook manual [10].

When the PC-AT computer is booted, a message similar to the one shown in Section 3.2.5.2 will appear on the screen. Respond by typing any key to run ARF or "**Ctrl C**" to get out. The NB Menu will appear on the screen when selecting the ARF program. Follow step (6) in Section 3.1.1 for setting the parameters, and then select **RUN.** Data will be displayed on the screen (Figure 6). The five windows on the bottom left hand corner of Figure 6 show the graphic displays of the pressure transducer signals (Pres.1 stands for differential pressure across the filter housing or test section in inch H_2O; and Pres.2 stands for differential pressure across the tunnel in inch H_2O), relative humidity (HUMID.in %), temperature (TEMP1 stands for temperature reading from the velocity meter in °C; TEMP.2 stands for temperature reading from the hygrometer in °C), and velocity (VEL. in m/s), respectively. The windows on the bottom right hand corner give the corresponding instantaneous meter reading of the signals shown on the left hand side. In addition, the top right hand corner shows the running time in seconds. Lastly, the two windows on the top are for future use, and could be used to input DMPS data (concentration and particle size) to the NB program.

A hard copy of the displays or menus can be obtained by pressing **Shift Print Scrn** key. Two other frequently used function keys are: <esc> to return to the previous menu and "**F1**" to provide help. The original data are stored in the LOTUS .prn format.

4.0 CALIBRATION

4.1 Humidity

The calibration procedure for the Rotronic HT250D hygrometer is given in Appendix III. The hygrometer was calibrated at 35 and 80% RH using RIC humidity standards. Since the full-scale output is 5V for 100%RH, the 35% potentiometer was adjusted so that the output is 1.75V at 35%RH. Similarly, the 80% potentiometer was adjusted to 4V at 80% RH.

Since the temperature sensor (Pt 100 RTD) from the Rotronic hygrometer is factory calibrated and requires no calibration, it was not calibrated. However, the sensor should be checked by following the calibration procedure outlined in Appendix III.

4.2 Velocity

The Testoterm instant action anemometer was compared with NRC's Kurtz certified mini-anemometer in NRC's Icing Wind Tunnel, see Figure 7 [11]. The velocity measurement from the Testoterm correlated very well with that from the Kurtz device. Further testing may be done by carrying out side by side velocity measurement with a pitot tube equipped with a micromanometer (within 0.005 in. water)

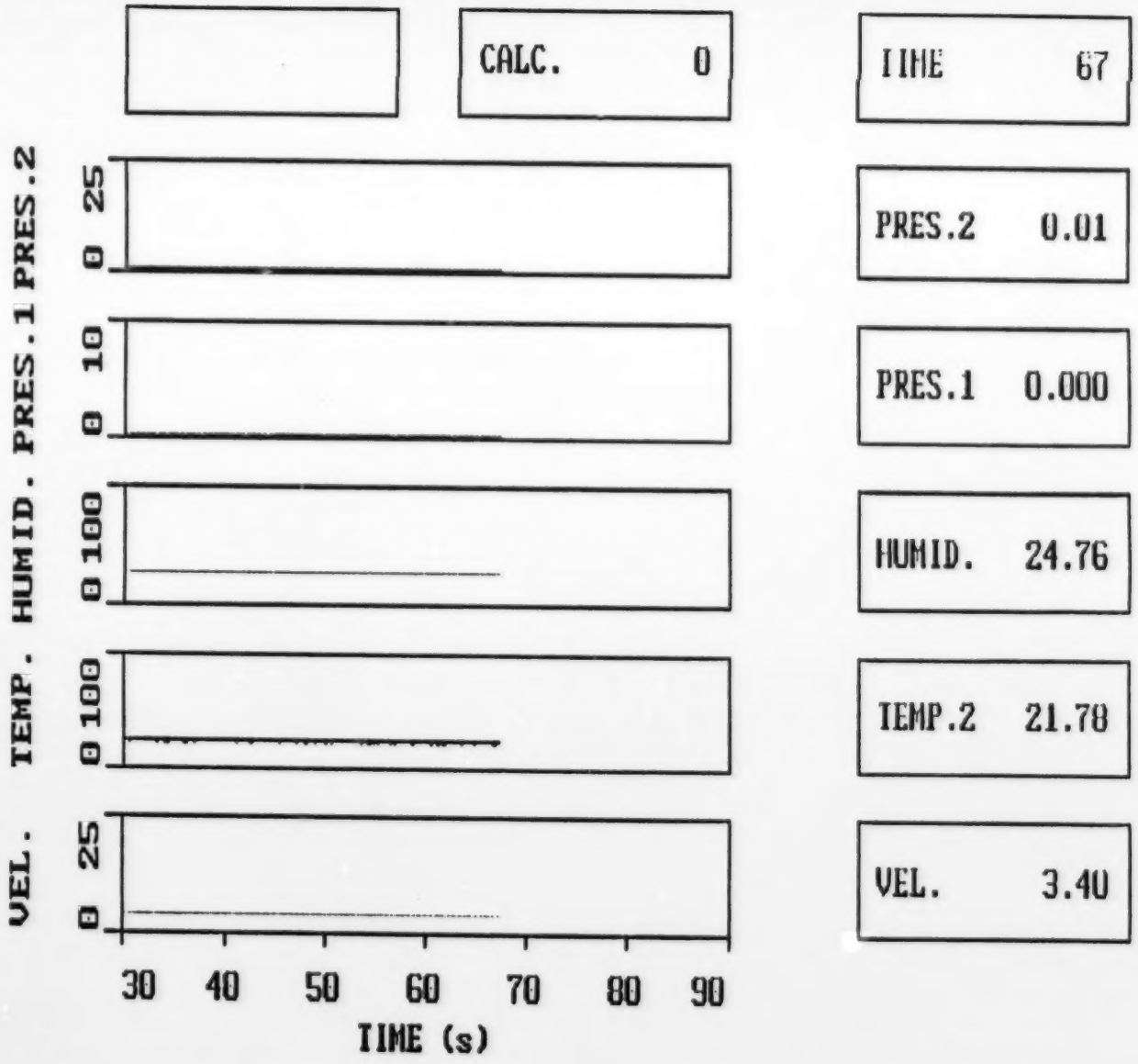


Figure 6. Graphic Displays on the Screen

Table 3. Setup for the Labtech Notebook

Ch. No	Interface Device	Int. Chan	Channel Name	Channel Type	Duration Seconds	Rate Hz	File Name	Wd #
1			RS-232	RS-232	360.000	10.000		6
2			CALC.	Calculated	360.000	10.000		13
3	1:Dash-1*	1	VEL.	Analog Input	360.000	10.000	91hld6a.prn	1
4	1:Dash-1*	2	TEMP.1	Analog Input	360.000	10.000	91hld6a.prn	2
5	1:Dash-1*	3	TEMP.2	Analog Input	360.000	10.000	91hld6a.prn	2
6	1:Dash-1*	4	HUMID.	Analog Input	360.000	10.000	91hld6a.prn	3
7	1:Dash-1*	5	PRES.1	Analog Input	360.000	10.000	91hld6a.prn	4
8	1:Dash-1*	6	PRES.2	Analog Input	360.000	10.000	91hld6a.prn	5
9			TIME	Time	360.000	1.000		12
10			VEL.	Calculated	360.000	1.000		7
11			TEMP.1	Calculated	360.000	1.000		
12			TEMP.2	Calculated	360.000	1.000		8
13			HUMID.	Calculated	360.000	1.000		9
14			PRES.1	Calculated	360.000	1.000		10
15			PRES.2	Calculated	360.000	1.000		11

4.3 Differential Pressure

The Setra 264 series differential pressure transducer was factory calibrated and should require no field adjustment. (See calibration procedure in Appendix III). However, the 0-10 inch range pressure transducer was checked, using the water manometer, and found to be within acceptable limits (see Figure 8).

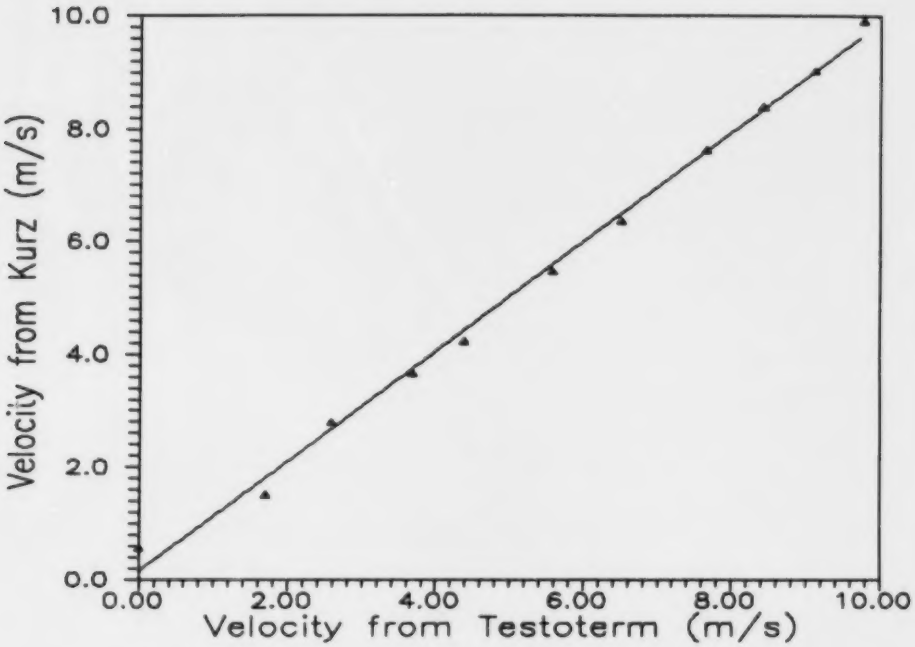


Figure 7. Velocity Comparison

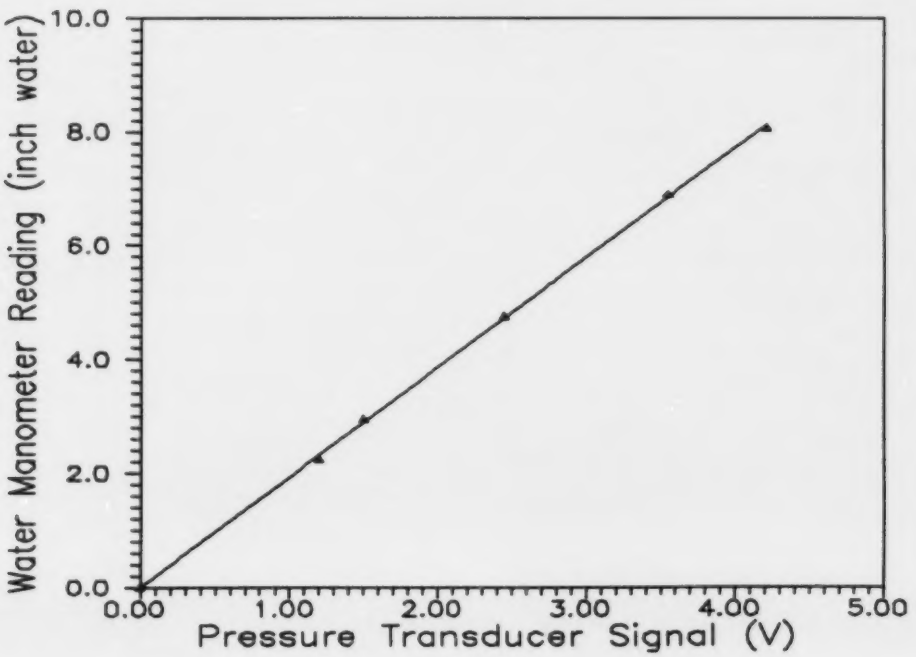


Figure 8. Pressure Transducer Calibration

5.0 COMMISSIONING TESTS

5.1 Noise Measurements

Noise measurements were carried out at locations within KT125 and in adjacent work areas by the Plant Equipment Dynamics Section of Research Division. Most measurements were made with the inlet filter installed. A few were repeated with the inlet filter removed. The preliminary findings and recommendations are provided in Appendix V. The findings indicated that the major noise component is the fan noise fed backwards through the duct. The noise from the duct inlet did not increase significantly with air velocity. With the inlet filter removed the noise from the duct inlet increased significantly because the fan noise was no longer attenuated by the filter. Table 4 indicates the noise levels at various locations within KT125 and in adjacent work areas.

Table 4. Noise Level At Locations Inside KT125 And In Adjacent Work Areas

	Location	Maximum Noise Level-dBA
1)	KT125 at operator position beside the duct	
	- fan off	66.8
	- with inlet filter	80.1
	- without inlet filter	88.6*
2)	On duct axis at 4 m from the inlet	
	- fan off	62.1
	- with inlet filter	86.5*
	- without filter	98.4*
3)	Fan room	
	- with inlet filter	90.3*
4)	Work area KT130 adjacent to KT125	
	-fan off	63.0
	-with inlet filter	74.0
5)	Conference room KT115 south of KT125	
	-fan off	51.6
	-with inlet filter	58.6
6)	Work area KT116 south of KT125	
	-fan off	69.5-76.7
	-with inlet filter	72.9

* Mandatory ear protection in excess of 85 dBA

5.2 Flow Visualization

Flow visualization tests employing smoke candles were carried out at different flow conditions and tunnel configurations. Since the facility is a multipurpose one, it will be used in a variety of applications, for example, filter testing, flow calibration and aerosol research studies. Generally speaking, a wide velocity range and steady flow conditions are desirable for flow calibration and measurements; on the other hand, uniformity of aerosol concentrations is desirable for filter testing work, which can be achieved by introducing the aerosols into a region of turbulence. In order to maintain steady flow, turbulent reducers such as honeycomb and wire screens are used. For applications such as filter testing, a mixing orifice is employed to introduce turbulence in the tunnel and hence provide good aerosol mixing. Smoke was introduced at the location of the aerosol injector before the mixing orifice, and its density was observed and recorded by video tape downstream, in the working section (see Figure 2). The smoke test demonstrated that with the turbulence reducer, the flow was very steady; on the other hand, the flow was very turbulent with the mixing orifice installed in the tunnel, and the density of the smoke appeared reasonable uniform. Velocity and aerosol concentration measurements were carried out to confirm this ob-observation. The results are given in the following sections.

5.3 Velocity Measurements

Velocity profiles were obtained by traversing with the upstream velocity probe, vertically across the tunnel, at nine positions (see Figure 2). The flow rate inside the tunnel was adjusted by changing the variable inlet vane (VIV) settings from 100% closure (Dist 1) to 0% closure (Dist 5). The effect of different tunnel configurations such as with the mixing orifice and turbulent reducer in place was examined. Table 5 shows the velocity profiles under these conditions. The tunnel is capable of providing velocities ranging from about 2 m/s to about 20 m/s depending on the VIV setting and tunnel configuration used.

The velocity profiles under Tests 1-3 were made with the turbulent reducers installed inside the tunnel and without the mixing orifice (see Table 5). The profiles were relatively flat except near the tunnel walls (see Figure 9), and the velocity was found to change within about 10% across the tunnel. Furthermore, the flow was very steady and varied in most cases about 1% with time. However, the presence of the flow nozzle caused a significant drop in the maximum velocity attained in the tunnel. The maximum velocity measured in Tests 1-2 was found to be about 5 m/s, much less than the expected maximum value of 20 m/s. This was possibly due to the substantial back pressure created by the flow nozzle just before the fan intake.

The velocity profiles under Tests 4 and 5 were made with the mixing orifice installed inside the tunnel (see Table 5). Substantial turbulence was created by the mixing orifice as the temporal variations of the velocity were found to be > 10% in most cases. The maximum velocity was found along the axis of the tunnel (see Figure 10). In Test 4, the close proximity of the mixing orifice and honeycomb-wire screens caused substantial spatial variation of velocity across the

Table 5. Velocity Measurements in the Tunnel

TEST CONDITIONS* No.	DISTANCE FROM BOTTOM OF THE TUNNEL (in)	VARIABLE INLET VANE SETTING									
		Dist 1		Dist 2		Dist 3		Dist 4		Dist 5	
		Wind Speed (m/s)	Std of WS (%)	Wind Speed (m/s)	Std of WS (%)	Wind Speed (m/s)	Std of WS (%)	Wind Speed (m/s)	Std of WS (%)	Wind Speed (m/s)	Std of WS (%)
1 NO MIXING PLATE	23.3	1.6	2.3	3.1	1.2	3.4	1.4	3.2	1.5	3.2	1.8
	20.8	2.2	0.0	4.1	0.0	4.4	0.8	4.5	1.3	4.5	1.1
	17.8	2.2	0.0	4.2	0.0	4.7	0.0	4.8	1.0	4.8	0.0
	14.8	2.4	0.0	4.4	0.9	4.8	0.0	4.9	0.0	5.0	1.0
	11.9	2.5	1.9	4.4	0.0	4.8	0.0	4.9	0.8	4.9	0.8
	8.9	2.5	1.9	4.4	1.1	4.8	0.0	4.9	0.0	4.9	0.0
	5.9	2.5	0.0	4.3	0.9	4.7	0.0	4.8	0.0	4.8	0.0
	3.0	2.3	2.1	4.1	0.0	4.5	0.0	4.6	0.0	4.6	0.8
	0.5	1.9	0.0	3.6	0.0	3.9	1.0	4.0	1.2	4.0	1.2
	AVG	2.2		4.1		4.4		4.5		4.5	
	% STD	12.6		10.2		10.5		12.0		12.0	
2 NO MIXING PLATE AND HONEYCOMB	23.3	2.3	3.2	3.7	5.7	3.6	10.5	4.0	12.5	3.3	7.3
	20.8	2.1	2.7	3.9	1.2	4.3	2.6	4.4	2.8	4.4	3.1
	17.8	2.2	3.4	4.2	2.3	4.5	4.4	4.7	2.5	4.7	2.3
	14.8	2.4	3.1	4.1	3.9	4.4	3.5	4.5	3.6	4.7	3.4
	11.9	2.3	2.2	4.2	1.1	4.6	3.6	4.6	3.2	4.7	4.1
	8.9	2.3	2.5	4.2	2.5	4.7	3.3	4.8	1.6	4.8	1.1
	5.9	2.2	2.6	4.3	2.7	4.5	2.4	4.8	2.8	4.7	2.7
	3.0	2.2	4.1	4.1	2.8	4.5	5.0	4.8	2.9	4.6	1.9
	0.5	2.1	6.4	3.8	1.9	4.4	5.5	4.2	3.9	4.4	6.0
	AVG	2.2		4.1		4.4		4.5		4.5	
	% STD	4.2		4.8		6.9		5.9		9.4	
3 NO MIXING PLATE AND FLOW NOZZLE	23.3										
	20.8										
	17.8	2.6	0.9	8.3	0.2	14.1	0.3	18.3	0.1	20.1	0.4
	14.8	2.7	0.7	8.4	0.2	14.2	0.3	18.5	0.3	20.3	0.3
	11.9	2.7	0.6	8.3	0.4	14.1	0.3	18.3	0.2	20.1	0.4
	8.9	2.7	0.7	8.3	0.2	14.0	0.3	18.2	0.2	20.0	0.2
	5.9	2.6	0.9	8.2	0.3	13.8	0.2	17.9	0.4	19.6	0.1
	3.0	2.5	0.9	7.9	0.7	13.3	0.4	17.2	0.5	18.7	0.4
	0.5	2.1	1.5	7.0	0.9	11.6	1.1	15.1	0.6	16.5	1.0
	AVG	2.6		8.0		13.6		17.6		19.3	
	% STD	7.2		5.8		6.3		6.3		6.5	
4 NO FLOW NOZZLE	23.3	2.3	10.2	4.1	9.2	5.2	10.7	5.5	12.6	5.8	7.9
	20.8	2.7	10.2	5.8	8.6	6.7	9.6	6.7	10.8	7.2	8.0
	17.8	3.2	6.6	7.0	8.3	8.3	5.5	8.2	4.9	8.4	8.9
	14.8	3.8	4.9	8.0	8.3	9.8	4.4	9.8	5.3	10.0	6.2
	11.9	3.9	7.1	8.6	6.3	9.8	4.9	10.5	5.4	10.6	6.1
	8.9	3.3	10.8	8.1	4.4	8.9	4.6	9.7	4.0	9.8	4.7
	5.9	2.7	17.3	7.0	5.9	7.8	6.0	8.2	8.1	8.0	11.1
	3.0	2.1	13.2	5.6	5.4	6.3	6.2	6.5	5.3	6.5	10.2
	0.5	1.9	17.9	4.8	10.7	5.4	10.3	5.8	8.9	5.8	8.0
	AVG	2.9		6.6		7.6		7.9		8.0	
	% STD	23.1		22.7		22.0		22.0		21.3	
5 NO HONEYCOMB WIRE SCREEN AND FLOW NOZZLE	23.3	2.1	9.8	5.0	13.8	6.4	12.6				
	20.8	2.6	13.8	5.5	9.5	7.2	10.5				
	17.8	2.7	14.7	6.5	10.1	7.8	6.3				
	14.8	3.2	10.2	6.8	8.7	8.7	9.9				
	11.9	3.1	11.7	7.7	8.9	9.3	9.0				
	8.9	3.1	13.2	7.4	7.9	8.8	7.3				
	5.9	2.9	12.1	6.5	7.4	7.9	7.8				
	3.0	2.7	10.1	5.6	13.3	7.4	10.2				
	0.5	2.5	13.5	5.9	12.0	6.8	11.5				
	AVG	2.8		6.3		7.8					
	% STD	11.6		13.3		11.7					

* Default condition has all the tunnel features as illustrated in Figure 2.

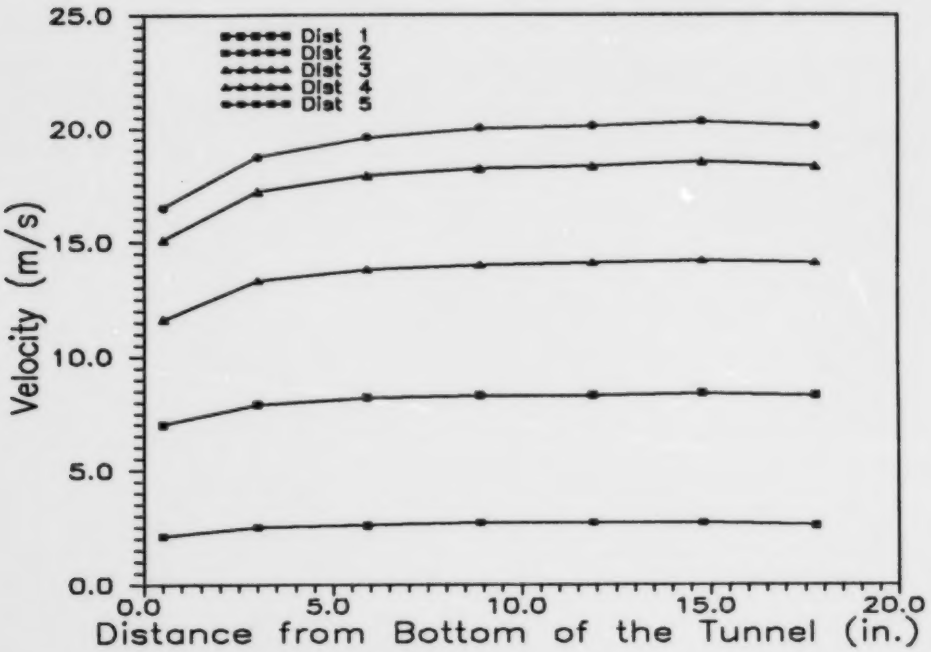


Figure 9. Velocity Profile under Test 3

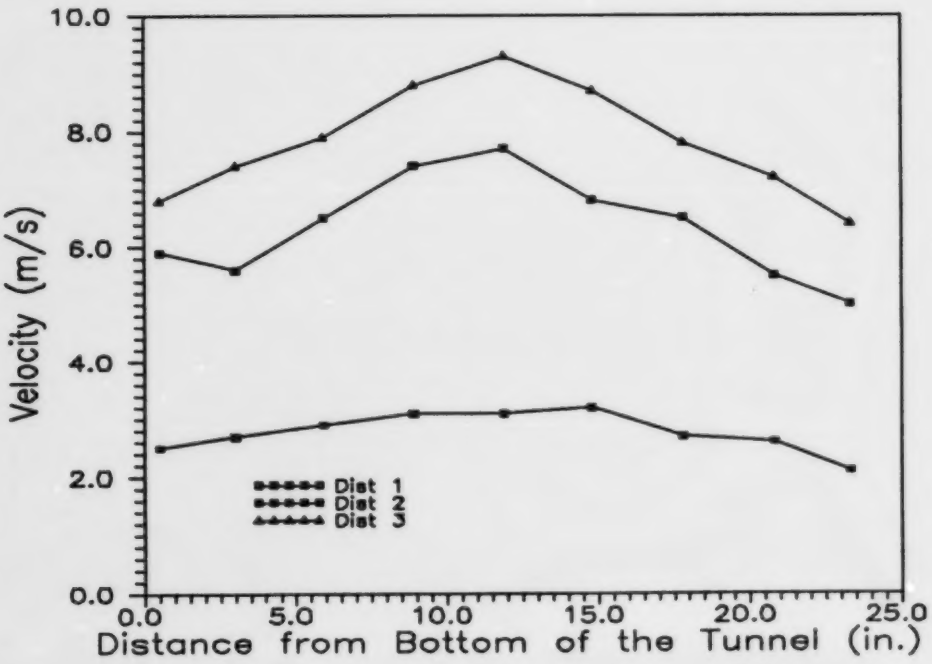


Figure 10. Velocity Profile under Test 5

tunnel. This problem could be resolved by placing the honeycomb and wire screens some distance downstream from the mixing orifice and before the upstream sampling section. This may allow sufficient time for the full expansion of the air jet from the mixing orifice before it is subjected to the turbulence reduction.

5.4 Aerosol Concentration Measurements

Aerosols were generated by atomizing a solution of 1 L uranine in deionized water by means of the 6-jet atomizer. The aerosol concentration inside the tunnel depends on the flow inside the tunnel, the number of jets used in the atomizer and the atomizer pressure. The concentration profiles across the tunnel were obtained by transversing with the sampling probe, vertically across the tunnel, at nine positions. The DMPS was used to measure the particle size and concentration. During this part of the tests, the VIV was set at DIST 1. A typical size spectrum is given in Figure 11. Table 6 and Figure 12 give the velocity and concentration profile across the tunnel. The spatial variations of the velocity and aerosol concentration were less than about $\pm$ 10%. A slight increase in aerosol concentration was observed with decreasing distance from the bottom of the tunnel, possibly due to settling of the aerosols.

Table 7 shows the stability of the aerosol concentration with time. The sampling tube was positioned at a distance of 11.9 inch from the bottom of the tunnel, and the velocity was about 2.5 m/s. The number concentration was found to vary within about $\pm$ 5 % and appeared to increase slightly with time. On the other hand, the geometric mean diameter of the particles was about 0.070 μm and did not change significantly. Based on the above findings, the 6- jet atomizer is capable of providing relatively stable aerosol concentration (within about $\pm$ 5%) for up to about three hours. The maximum concentration was about 60,000 particles/cm^3 under the test conditions.

6.0 CONCLUDING REMARKS

Relevant and comprehensive information on the operation of the Aerosol Research Facility is given in this report, which is aimed at getting one started with the facility as quickly as possible, without having to read several volumes of operating manuals first. However, this is, by no means, a full replacement of the operating manuals, which will become very handy in trouble shooting and in providing additional features, if desired.

The commissioning tests demonstrated that the facility is capable of providing velocity ranging from about 2 to about 20 m/s, and maximum aerosol concentrations of about 60,000 particles/cm^3 at a velocity of about 2.5 m/s. With the use of the honeycomb and wire screens, the variation in airspeed across the tunnel has been reduced to within $\pm$ 10%; the corresponding temporal variation was within about $\pm$ 1%. Similarly, with the use of the mixing orifice, the variation of aerosol concentration was found to be within $\pm$ 8%.

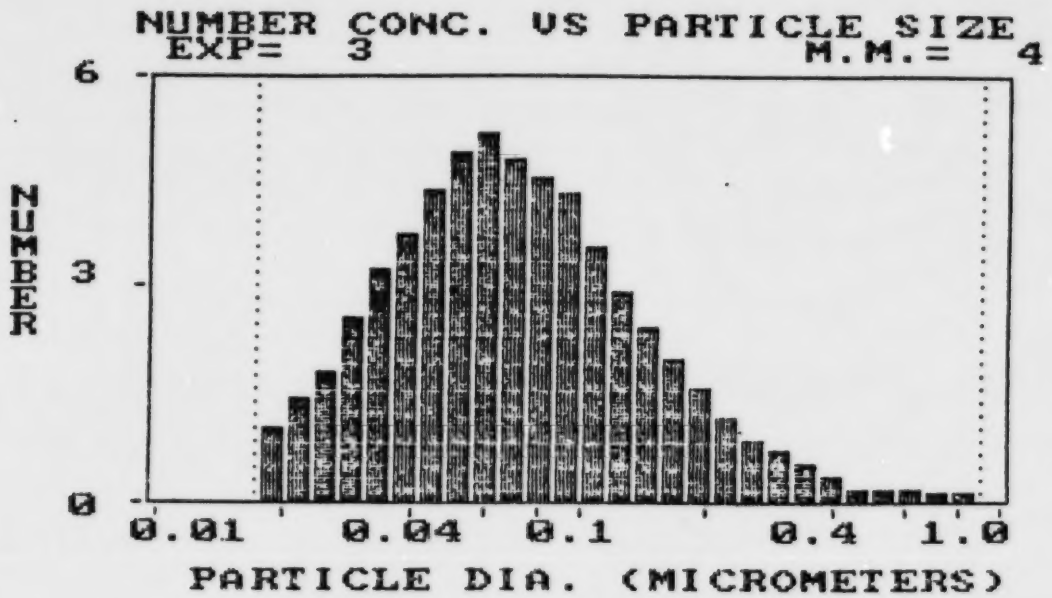


Figure 11. Typical Size Spectrum

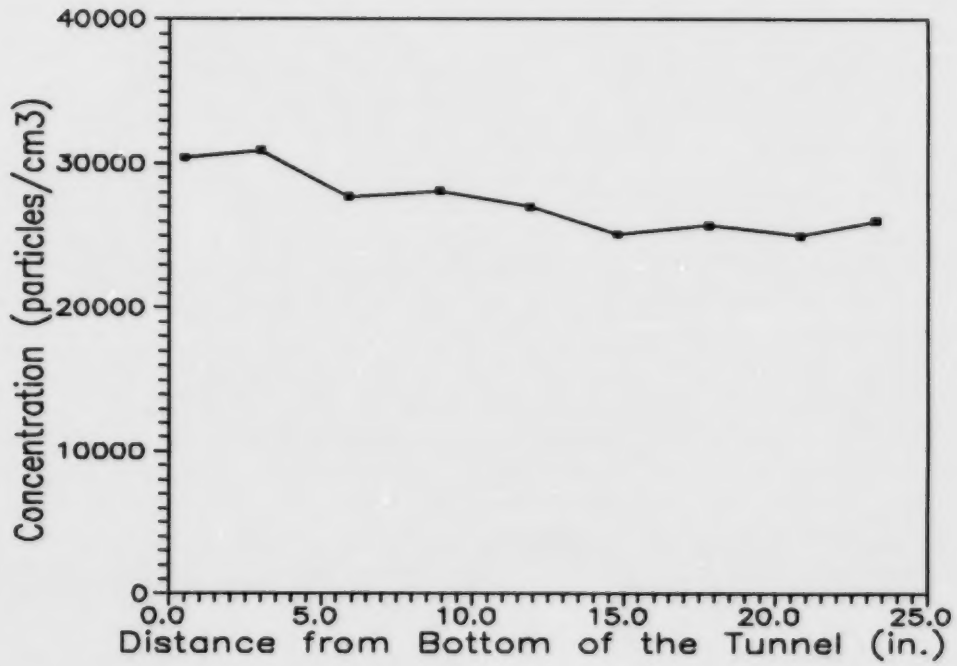


Figure 12. Concentration Profile

Table 6. Aerosol Concentration Measurements in the Tunnel (VIV set at DIS 1, no honeycomb-wire screen-flow nozzle)

DISTANCE FROM THE BOTTOM OF THE TUNNEL (in.)	TEMPERATURE (°C)	HUMIDITY (%)	VELOCITY (m/s)	NUMBER CONCENTRATION (Particles/cm³)
23.3	26.5	53.2	2.1	26000
20.8	26.3	52.3	2.3	25000
17.8	26.4	55.3	2.5	25700
14.8	26.3	53.1	2.8	25100
11.9	26.3	51.8	2.8	27000
8.9	25.9	53.9	2.6	28100
5.9	26.0	53.0	2.6	27700
3.0	27.6	53.9	2.4	30900
0.5	26.0	53.9	2.5	30400
AVG	26.4	53.4	2.5	27322
% STD	1.8	1.8	8.5	7.5

Table 7. Aerosol Concentration over Time (VIV set at DIST 1, no honeycomb-wire screen-flow nozzle)

TIME FROM START (min)	NUMBER CONCENTRATION (Particles/cm³)	GEOMETRIC MEAN DIAMETER (µm)
8	59100	0.071
16	59100	0.070
24	59500	0.070
32	59100	0.071
40	60200	0.070
48	59700	0.070
56	60400	0.070
64	59900	0.070
72	59700	0.071
80	62700	0.071
88	62400	0.071
96	64100	0.070
104	63800	0.070
112	64400	0.070
120	62600	0.071
128	64900	0.071
136	66300	0.071
144	65500	0.071
152	66300	0.071
160	67100	0.070
168	67400	0.069
AVG	62581	0.070
%STD	5	1

7.0 RECOMMENDATIONS

1) Airspeed lower than 2 m/s is desirable for testing carbon and HEPA filters and determining the performance of a demister. This can be achieved by reducing the fan RPM by changing the V-belt drive on the fan assembly. Based on the following fan equations, the characteristic of the fan with the modified V-belt drive will be different from those given in Appendix I [12]:

$$CFM_c = CFM \times RPM_c/RPM$$

$$SP_c = SP \times (RPM_c/RPM)^2$$

$$BHP_c = BHP \times (RPM_c/RPM)^3$$

where CFM = the flow rate (ft^3/min)

RPM = fan speed (rev/min)

BHP = Brake horsepower (HP)

Subscript c = change in RPM

For example, with the RPM reduced by half, the velocity in the tunnel is estimated to be about 0.8- 2.5 m/s. The V-belt drive systems required to reduce the RPM by a half and a tenth have been ordered.

2) A definite time schedule should be set up for the fan maintenance according to the Canadian Blower Service Manual [13].

3) The DMPS basic program could be modified so that the concentration and size data could be sent via the serial communication port directly to the Labtech Notebook program. Furthermore, a mass flow controller could be used to facilitate flow adjustment in the DMPS.

4) A three way control valve could be set up between the upstream sampling tube, downstream sampling tube and the DMPS system, so that automatic sampling between the upstream and downstream sections could be controlled via the DASH16F and the Labtech Notebook software. There should be little restriction inside the valve, and short sampling lines, to minimize aerosol deposition.

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Reviewed by:

O.T. Melo
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REFERENCES

1) Anyas-Weiss, N., O.T. Melo and G.L. Vascotto (1986). "1986 Report of the Environmental Program Champions Task Group,", Ontario Hydro Research Division.

2) Ogram, G.L., H. Leung and A. Lemyk (1988). "Aerosol Research Within the Environmental Science Section 1987: Summary Report", Ontario Hydro Research Division Report 88-82-K.

3) Leung, H (1988). "Design of a Multipurpose Aerosol Research Facility", Ontario Hydro Research Division Report 88-69-K.

4) Differential Mobility Particle Sizer System 3932 Software Instruction Manual, TSI Inc (1984).

5) Model 3077 Aerosol Neutralizer Operating and Service Manual, TSI Inc. (1977)

6) TSI Model 1030706 DMPS Interface Box Instruction Manual, TSI Inc. (1985)

7) Model 9306 Six-Jet Atomizer Instruction Manual, TSI Inc.(1883)

8) Model 3020 Condensation Nucleus Counter, Instruction Manual, TSI Inc. (1984)

9) DASH-16/16F Manual, MetraByte Corporation (1986)

10) Labtech Notebook Manual, Version 4, Laboratory Technologies Corporation (1988)

11) Leung, H (1980). "Calibration of Fog Water Collection and Detection Equipment at the NRC Low Temperature Laboratory", Ontario Hydro Research Division Report 90-197-K.

12) Fans and Systems, AMCA publication 201.

13) Centrifugal Fans Service Manual, Canadian Blower/Canada Pumps Limited, Kitchener, Ontario.

APPENDIX I

A LIST OF CONTACT PERSONS

1) **Fan Order**

Mr. Dave Carpenter
Canadian Blower/Canadian Pumps Limited
1220 Sheppard Avenue East, Suite 402
Willowdale, Ontario M2K 2S5
Tel: 416-497-0308

2) **Rotronic Hygrometer and Setra Differential Pressure Transducer Order**

Mr. Jerry Sand
Alpha Controls and Instrumentation
361 Steelcase Rd. West, Unit 3
Markham, On L3R 3V8
Tel: 416-477-213

3) **Duct Order**

Canadian Rogers Eastern Limited
108 Vine Avenue
Toronto, On M6P 1V7
Tel: 416-762-7211
(Also Jimmy Bingham, Model shop, ext 6583)

4) **Velocity Meter Order**

Transcat
P.O. Box 456, Station A
Rexdale, Ontario M9W 5L4
Tel: 416-675-5980

5) **Noise Measurement**

Mr. John Kowalewski
Plant Equipment Dynamics Section
Mechanical Research Division
KR278, ext 6178

APPENDIX II

FAN SPECIFICATION AND PERFORMANCE CURVE

CANADIAN BLOWER/CANADA PUMPS. KITCHENER. ONT. PERFORMANCE CURVES

FOR: ONTARIO HYDRO

SIZE & TYPE: 400 BL SWSI T01

3081 RPM 70 °F 29.92 IN. HG .075 LB/FT³

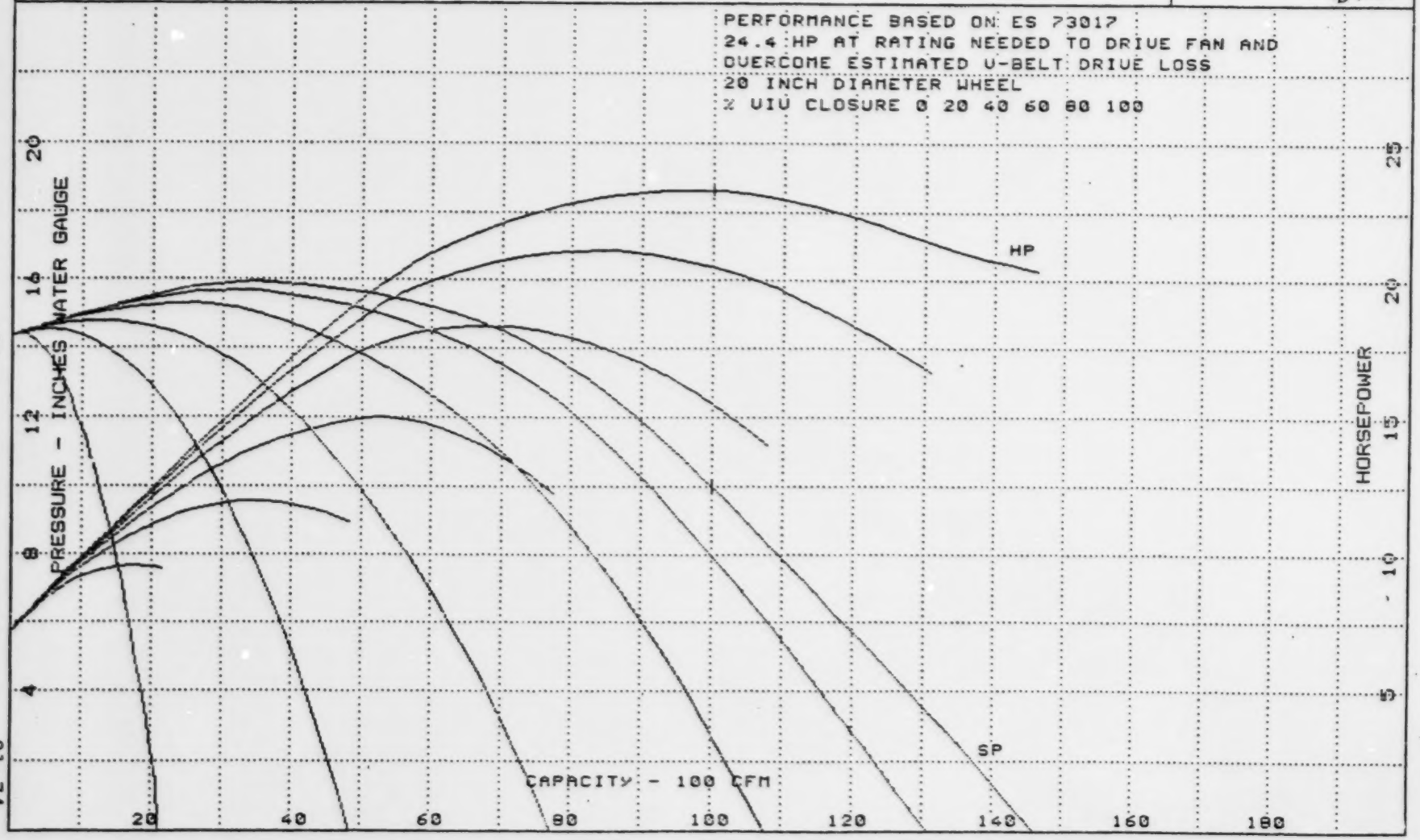
CPD: 880387

ORDER: 88H1254T2

DATE: 09/12/1988

AM

PERFORMANCE BASED ON ES 73017
24.4 HP AT RATING NEEDED TO DRIVE FAN AND OVERCOME ESTIMATED V-BELT DRIVE LOSS
20 INCH DIAMETER WHEEL
% VIV CLOSURE 0 20 40 60 80 100



36

91-74

CANADIAN BLOWER/CANADA PUMPS SOUND EVALUATION DATE: 09/12/1988

ORDER : 88H1254T2 APPROVED BY:
FOR : ONTARIO HYDRO
SIZE & TYPE: 400 BL SWSI T01 20.00 IN. DIAM

FLOW AND PRESSURE AT 100% OPEN VIV SETTING
RATING: 10000. CFM 10.00 SP 4382 OV 23.3 BHP .0750 DENS
70. DEG F 29.92 IN HG BAR.

ACCESSORIES: VIV

3081 RPM 12 BLADES BLADE FREQUENCY BAND IS NUMBER 4

	OCTAVE BAND NO 1	2	3	4	5	6	7	8
SOUND POWER LEVELS(PWL) IN dB RE 1.0E-12 WATTS								
PWL FAN WITH VIV AT 70% FLOW	126	116	112	112	107	102	98	93
PWL INLET	114	109	107	109	104	99	95	90
PWL OUTLET	112	107	107	109	104	99	95	90
PWL CASING	107	97	93	93	88	83	79	74
SOUND PRESSURE LEVELS(SPL) IN dB RE .0002 MICROBAR								
SPL INLET AT 3.00 FT	113	108	106	108	103	98	94	89
SPL OUTLET AT 3.00 FT	111	106	106	108	103	98	94	89
SPL CASING AT 3.00 FT	98	88	84	84	79	74	70	65

NOISE LEVELS ON THE A WEIGHTED SCALE
dB(A) INLET 108 AT 3.00 FT
dB(A) OUTLET 108 AT 3.00 FT
dB(A) CASING 84 AT 3.00 FT

BASED ON ES NUMBER	73017.S
EFFICIENCY CORRECTION	3 dB
CASING THICKNESS - STEEL	.1345 INCHES
NEAR FIELD	1.2 FEET
DIRECTIVITY FACTOR - INLET & OUTLET	8
DIRECTIVITY FACTOR - CASING	2

SPL CASING AND dB(A) CASING VALUES MAY BE TOO LOW BY UP TO 15 dB BECAUSE ASSUMPTIONS OF UNIFORM FIELD AND MINUMUM CONTRIBUTIONS DUE TO VIBRATING OR FLANKING PATHS MAY NOT BE JUSTIFIED.

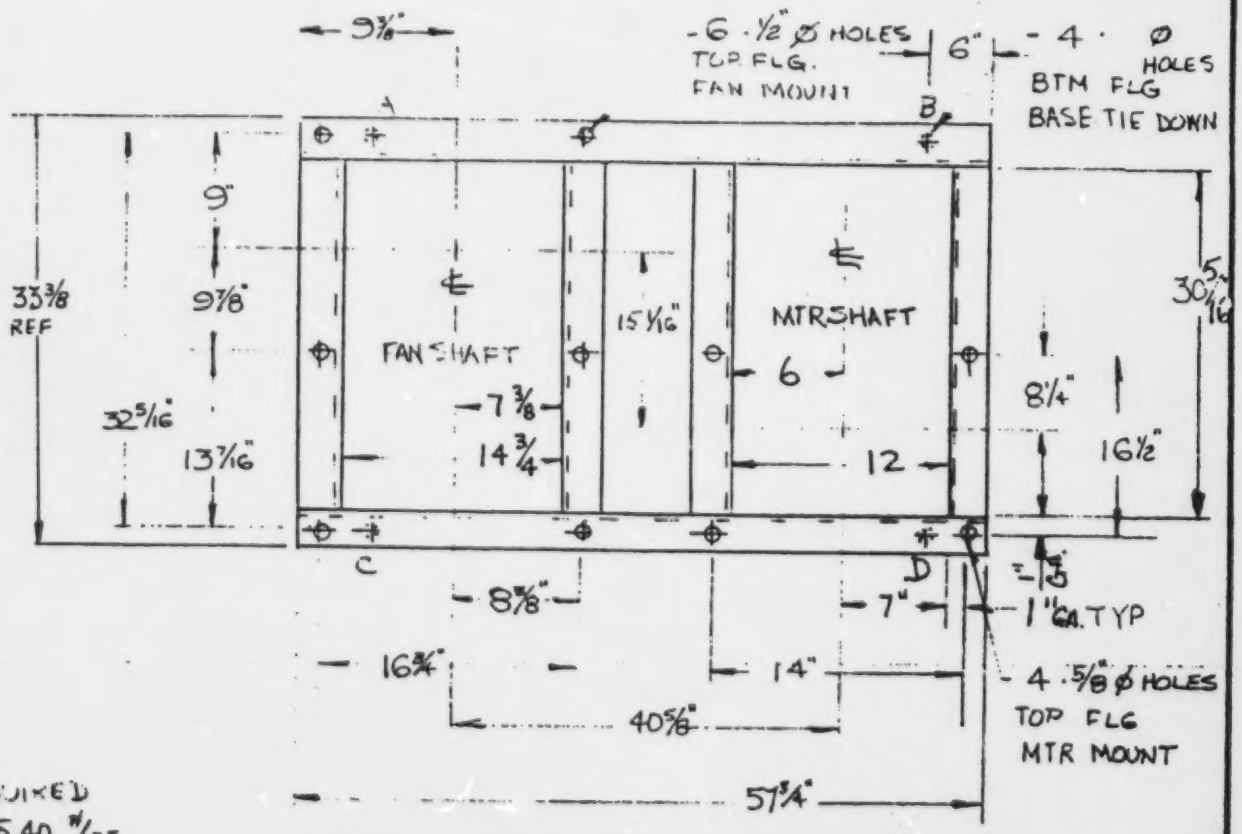
MAXIMUM NOISE LEVELS FOR FANS WITH VIV'S OCCUR AT 70% FLOW.

END REFLECTION CORRECTION HAS BEEN APPLIED TO THE INLET AND OUTLET SOUND POWER LEVELS BASED ON THE INLET AND OUTLET AREAS.

CASING VALUES ASSUME INLET AND OUTLET NOISE IS DUCTED AWAY.

SOUND PRESSURE LEVELS OR NOISE LEVELS CANNOT BE GUARANTEED BECAUSE CANADIAN BLOWER/CANADA PUMPS DOES NOT HAVE CONTROL OVER ENVIRONMENTAL FACTORS WHICH DETERMINE THESE LEVELS.

SOUND PRESSURE LEVELS ARE CALCULATED ASSUMING FREE FIELD CONDITIONS.



QUANTITY: ONE ONLY REQUIRED

CONSTRUCTION: 4"] @ 5.40 #/FT.

MTR SLIDE BASE FR. 286T

NOTES: 1) TOP OF BASE TO BE FLUSH & SQUARE.

2) GRIND ALL WELDS SMOOTH.

3) FINISH: ONE COAT PRIMER

4) TO SUIT: 400 BL, CCW, TH, ARRI, CL III MTR. FR. 286T, POS 'W', @ 42.6" CTRS

REF# 88H1254T2T01 (1) 400BLS

J P ENVIRONMENTAL PRODUCTS INC.

KITCHENER, ONTARIO

SCALE N.T.S.	APPROVED BY	DRAWN BY M.K./
DATE 13 SEPT 88		REVISED

CANADIAN BLOWER/CANADA PUMPS LTD

PO# 805119

CHANNEL BASE 400 BLS

DRAWING NUMBER 88459A1

38
91-74

CANADIAN BUFFALO

Ventilateurs Canadiens / Pompes Canada LIMITEE
Canad. Blower / Canada Pumps MITED

90 WOODSIDE AVE., KITCHENER, ONTARIO N2G 4K1
TEL. (519) 744-8111 TELEX: 069-55485 DUNS - 20 - 124 - 3078

FACTORY ORDER NO. / NO. DE REFERENCE: 88H1254T2

SOLD TO / VENDU A: ONTARIO HYDRO
700 UNIVERSITY AVE.
44 . TORONTO, ONTARIO
M5G 1X6

FILE

SHIP TO / EXPEDIER A: SAME, ONTARIO HYDRO
C/O 800 KIPLING AVE.
TORONTO, ONTARIO
BUILDING KR219
P.O. 18-42313-11
SHIPMENT TAG / ETIQUETTE (D'EXPEDITION) REQ. 0865-8220

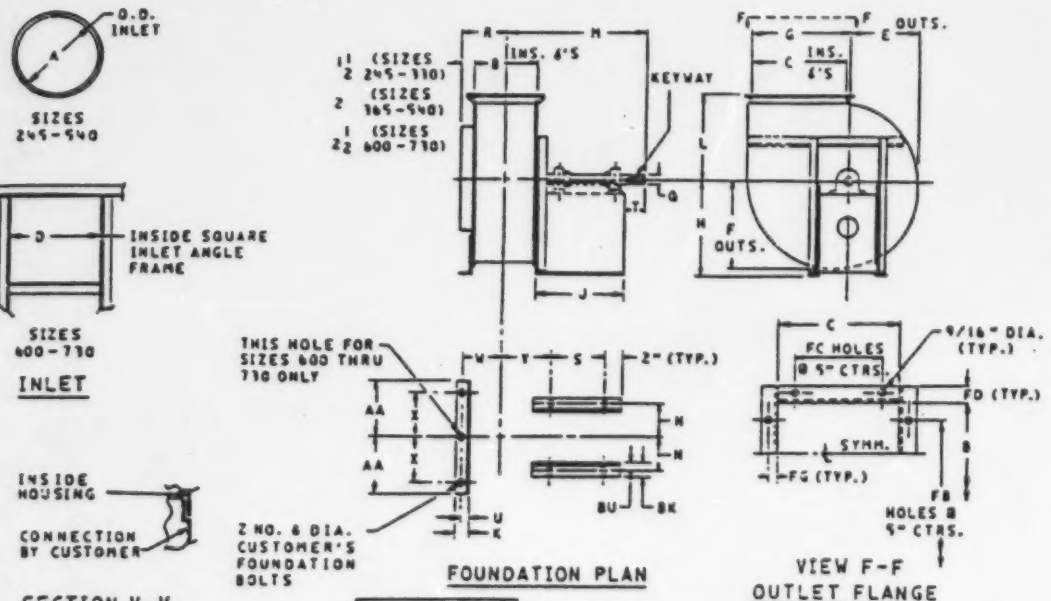
SENT CORRECT CERTIFIED: DM 9-8-88
APPROVAL/APPROBATION:
REVISED/REVISE:
NAME PLATE TAG / ETIQUETTE
USED BY / POUR

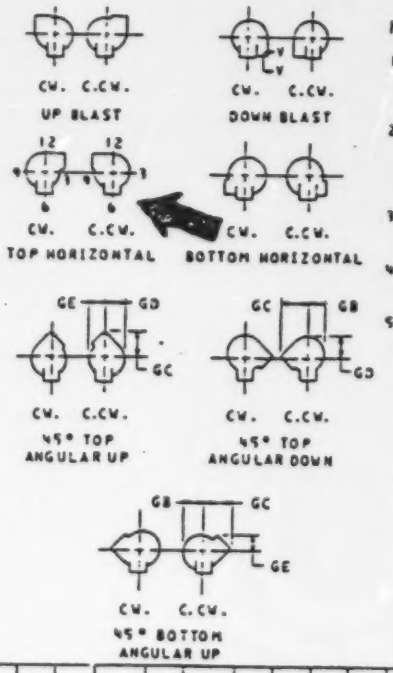
DATE	ORDER/COMMANDE	TAXE FED. TAX	TAXE PROV. TAX	CUST. CODE/CLIENT	REQUIRED/REQUIS	DELIVERY/LIVRAI
AUG. 12/88	NO. 18-42313-11	EXTRA 8%	NO. EXEMPT		09/30/88	10/12/88

VIA	TRUCK / CAMION	RAIL / V.F.	PPD P.A. / P & A	COLL. / P.V.	PPD & CHGE / P&CH	F.O.B. / F.A.B.	INV./FACT.	BRANCH/BUREAU	SALESMAN/INCO
GLENGARRY	X			X		KITCHENER		TORONTO	DC

CONFIRM/INCL: 6#

| ITEM | QTY/QTEE | DESCRIPTION | | |





NOTES:

1. DRAWING SHOWS CLOCKWISE ROTATION AND UP BLAST DISCHARGE. FAN IS FURNISHED AS REQUIRED PER ORDER.
2. WHEN ACCESS DOOR IS REQUIRED, SPECIFY DOOR (BY THE HANDS OF THE CLOCK FROM THE DRIVE SIDE. (REFER TOP HORIZONTAL DISCHARGE KEY SKETCH.)
3. OUTLET ANGLE NOT USED ON DOWN BLAST DISCHARGE. FOR DUCT CONNECTION SEE SECTION V-V.
4. REFER TO BELT CENTER WHITE PRINT FOR MAXIMUM MOTOR SIZES FOR ARRANGEMENT 9.
5. FOR 9L SIZES 245 THRU 300 WITH MOTOR FRAME 182T AND UP: 'H' DIMENSION INCREASES BY 2 1/2".

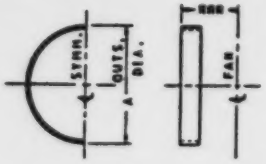
KEY SKETCHES

(SEE NOTE #5)

SIZE	A	B	C	D	E	F	G	H (SEE NOTE #5) US. DB. TH. TAU. TAD	H BAU	H BH	J	K	L US. DB TH. BH	L TAU. TAD. BAU	M	N	Q	KEYWAY	R	S	T	U	W	X	Y	Z	AA	BK	BU	FB	FC	FD	FG	GB	GC	GD	GE	KA
245	15 3/4	9 11/16	13 7/16	—	10 17/32	12 17/32	13 13/32	14	14	16 1/2	15 15/16	2	10 3/8	13	24 1/2	7 1/4	1 11/16	3/8 x 3/16 x 3 1/4	6 5/16	11 15/16	3 3/4	1 1/8	5 15/16	7 1/4	6 13/16	6-1/2	8 1/4	2	1 1/8	3	3	1 1/2	7/8	11 5/8	19 5/8	13 1/4	9 3/4	23
270	17	10 11/16	14 13/16	—	11 17/32	13 25/32	14 25/32	16 1/2	16 1/2	16 1/2	15 15/16	2	11 1/4	13	25	7 1/4	1 11/16	3/8 x 3/16 x 3 1/4	6 13/16	11 15/16	3 3/4	1 1/8	6 7/16	7 1/4	7 5/16	6-1/2	8 1/4	2	1 1/8	3	3	1 1/2	7/8	12 3/4	20 5/8	14 5/8	10 5/8	25
300	19	11 13/16	16 7/16	—	12 11/16	15 3/16	16 13/32	16 1/2	16 1/2	19	15 15/16	2	12 1/8	13	26 9/16	7 1/4	1 11/16	3/8 x 3/16 x 3 1/4	7 3/8	11 15/16	4 3/4	1 1/8	7	7 1/4	7 7/8	6-1/2	8 1/4	2	1 1/8	3	3	1 1/2	7/8	14	21 1/4	16 1/8	11 3/4	28
330	20 1/8	13 1/16	18 1/16	—	13 15/16	16 11/16	18 1/32	18	18	20 1/2	17 7/16	2	13 1/4	13 1/4	29 11/16	8 3/8	1 11/16	3/8 x 3/16 x 4	8	13 7/16	4 3/4	1 1/8	7 5/8	8 3/8	8 1/2	6-1/2	9 3/8	2	1 1/8	3	4	1 1/2	7/8	15 3/8	23 1/8	17 5/8	12 7/8	28
365	23 1/8	14 7/16	19 15/16	—	15 3/8	18 3/8	19 29/32	21 3/4	21 3/4	21 3/4	17 7/16	2	14 3/8	14 3/8	28 3/4	8 3/8	1 15/16	1/2 x 1/4 x 4 1/4	9 3/16	13 7/16	3 15/16	1 1/8	8 5/16	8 3/8	9 3/16	6-1/2	9 3/8	2	1 1/8	4	4	1 1/2	7/8	16 7/8	25 1/4	19 1/2	14 1/8	28
400	24 7/8	15 13/16	21 13/16	—	16 13/16	20 1/16	21 25/32	21 3/4	21 3/4	24 1/4	17 7/16	2	15 5/8	15 5/8	29 3/4	8 3/8	1 15/16	1/2 x 1/4 x 4 1/4	9 7/8	13 7/16	4 7/16	1 1/8	9	8 3/8	9 7/8	6-1/2	9 3/8	2	1 1/8	4	4	1 1/2	7/8	18 1/2	27 1/2	21 1/4	15 1/2	28
445	27 1/4	17 9/16	24 3/16	—	18 5/8	22 1/4	24 7/32	24	24	26 1/2	19 1/16	2	17 1/8	17 1/8	32 1/16	9 3/4	1 15/16	1/2 x 1/4 x 4 1/4	10 3/4	15 1/16	4 3/8	1 1/8	9 7/8	9 3/4	10 3/4	6-5/8	11 1/4	2	1 1/8	4	5	1 1/2	7/8	20 1/2	30 1/4	23 1/2	17 1/8	28
490	29 5/8	19 5/16	26 11/16	—	23 7/16	24 7/16	26 21/32	26 1/4	30 1/4	30 1/4	19 1/16	2	18 5/8	18 5/8	33 9/16	9 3/4	2 3/16	1/2 x 1/4 x 4 3/4	11 5/8	15 1/16	4 7/8	1 1/8	10 1/4	9 3/4	11 5/8	6-5/8	11 1/4	2	1 1/8	5	5	1 1/2	7/8	22 1/2	33	25 7/8	19 3/4	28
543	32 1/2	21 5/16	29 5/16	—	22 7/16	26 29/32	29 13/32	30 1/2	30 1/2	34 1/2	22 15/16	2	20 1/4	20 1/4	39 11/16	9 3/4	2 3/16	1/2 x 1/4 x 5 3/8	12 5/8	18 15/16	6 1/8	1 1/8	11 3/4	9 3/4	12 5/8	6-5/8	11 1/4	2	1 1/8	5	6	1 1/2	7/8	24 3/4	36 1/8	29 1/2	20 5/8	29
600	—	23 9/16	32 9/16	36	25 5/32	30 3/32	32 21/32	30 1/2	36 1/2	36 1/2	22 15/16	2 1/2	23 1/4	31	41 5/16	9 3/4	2 7/16	5/8 x 5/16 x 6 3/8	14 1/4	18 15/16	6 5/8	1 3/8	13 1/8	15 3/4	13 3/4	7-5/8	20	2	1 1/8	6	6	2	1 1/8	27 5/8	46 3/8	31 7/8	23 1/8	29
660	—	25 15/16	35 13/16	38 3/4	27 9/16	32 31/32	35 29/32	33 1/2	39 1/2	39 1/2	22 15/16	2 1/2	25 1/4	33 1/2	42 3/4	9 3/4	2 11/16	5/8 x 5/16 x 6 3/8	15 7/16	18 15/16	6 7/8	1 3/8	14 5/16	17	14 15/16	7-5/8	21 3/8	2	1 1/8	6	7	2	1 1/8	30 1/4	50 1/2	34 3/8	25 3/8	29
730	—	28 9/16	39 9/16	42 1/4	30 3/8	36 3/8	39 21/32	36 1/2	42 1/2	42 1/2	22 15/16	2 1/2	27 3/4	35 1/2	43 13/16	10 3/16	2 11/16	5/8 x 5/16 x 6 3/8	16 3/4	18 7/16	6 5/8	1 3/8	15 5/8	18 1/2	18 3/4	7-5/8	23 3/8	2 1/2	1 1/8	7	8	2	1 1/8	33 3/8	54 1/2	38 1/2	27 7/8	29

CERTIFIED CORRECT FOR CONSTRUC PURPOSES CH'K BY 9-8-88 DATE	FOR APPROVAL YES ☐ NO ☐ FABRICATION WILL NOT BEGIN UNTIL THIS PRINT IS RETURNED APPROVED OR WITH CHANGES NOTED.	REVISED YES ☐ NO ☐ DESTROY ALL PRINTS SUBMITTED PREVIOUS TO: DATE	DRAWN MAY 28/85 LATEST REV. — CB/CP NO. 88#1254T-2 SHOP ORDER NO. TO 1 DES. NO. F - 1569	BL FANS — SINGLE INLET ARR. 1 & 9, CLASS III
			Canadian Ice/Canada Fans Limited Kitchener, Ontario	WHITE PRINT SIZE 0426 x 0

CLASS I, II & III, SGL. ROUND INLET FOR SLIP CONNECTION

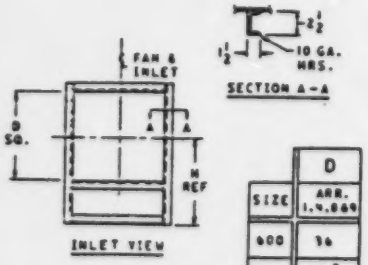


ROUND SLIP CONNECTION AS SHOWN IS SPECIAL FOR THESE SIZES WHERE INLET IS NORMALLY SUPPLIED SQUARE AND A FLANGE CONNECTION IS NOT REQUIRED. ROUND INLETS FOR THESE ARE SUPPLIED ONLY WHEN ORDERED.

SIZE	A		RRR			
	ARR. 1, 2, 4, 8, 8 9	ARR. 3	ARR. 1,2,4,8,8 9 CL. 182	ARR. 1,2,4,8,8 9 CL. 3	ARR. 3 CL. 182	ARR. 3 CL. 3
600	35 1/2	35 5/8	15 3/8	15 7/16	15 7/8	15 15/16
660	38 1/2	38 5/8	16 9/16	16 5/8	17 1/16	17 1/8
730	42	42 1/8	17 7/8	17 15/16	18 3/8	18 7/16
805	45 5/8	45 3/4	19 5/16	19 3/8	21 13/16	21 7/8
890	50 3/4	51	21	21 9/16	23 1/2	23 9/16
980	55 1/8	55 3/8	22 11/16	23 1/4	25 3/16	25 1/4
1085	60 3/8	60 5/8	24 3/4	24 15/16	27 1/4	27 5/16
1200	67	67 1/4	27 1/2	28 9/16	29 1/2	29 9/16
1320	73 1/4	73 1/4	31 13/16	31 7/8	31 13/16	31 7/8
1460	80 1/4	80 1/4	34 9/16	34 9/16	34 9/16	34 9/16

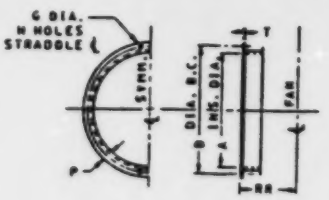
CLASS I, II & III SQUARE FLANGED INLET

SQUARE FLANGED INLET AS SHOWN IS SPECIAL FOR THESE SIZES AND IS FURNISHED ONLY WHEN ORDERED. NORMALLY, A SQUARE SLIP INLET IS SUPPLIED AS STANDARD.



SIZE	D ARR. 1,4,8&9
600	36
660	39 3/4
730	42 1/4

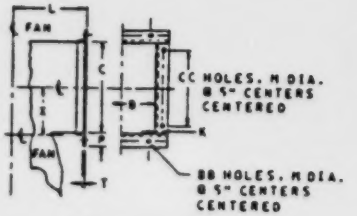
CLASS I, II & III, SGL. INLET FLANGE



REFER SPECIFIC FAN DRAWINGS FOR SLIP INLET DETAILS SUPPLIED AS STANDARD. INLET IS ARE ROUND ON SIZES 245 - 540 AND 1615 - 2175. INLETS ARE SQUARE ON SIZES 600 - 1460. ROUND FLANGED INLETS SHOWN HERE ARE SUPPLIED ONLY WHEN ORDERED.

SIZE	A		D		G	H	P	RR				T
	ARR. 1, 2, 4, 8, 8 9	ARR. 3	ARR. 1, 2, 4, 8, 8 9	ARR. 3				ARR. 1,2,4,8&9 CL. 182	ARR. 1,2,4,8&9 CL. 3	ARR. 3 CL. 182	ARR. 3 CL. 3	
245	15 1/2	—	17	—	5/16	12	1 1/2	6 3/8	6 7/16	—	—	3/16
270	16 3/4	—	18 1/4	—	5/16	12	1 1/2	6 7/8	6 15/16	—	—	3/16
300	18 3/4	—	20 1/2	—	5/16	12	1 1/2	7 3/8	7 7/16	—	—	3/16
330	19 7/8	—	21 7/8	—	5/16	12	1 1/2	8	8 1/16	—	—	3/16
365	22 1/4	—	24 1/2	—	5/16	14	1 1/2	9 1/8	9 3/16	—	—	3/16
400	24 1/2	—	26 1/4	—	5/16	16	1 1/2	11 13/16	11 7/8	—	—	3/16
445	27 1/8	—	28 7/8	—	5/16	16	1 1/2	12 13/16	12 7/8	—	—	3/16
490	29 1/4	—	31	—	5/16	16	1 1/2	13 9/16	13 5/8	—	—	3/16
540	32 1/8	—	33 7/8	—	5/16	16	1 1/2	14 9/16	14 5/8	—	—	3/16
600	35 9/16	35 11/16	37 1/2	37 5/8	7/16	16	2	15 7/16	15 1/2	15 15/16	16 1/16	1/4
660	38 9/16	38 11/16	40 1/2	40 5/8	7/16	16	2	16 5/8	16 11/16	17 1/8	17 3/16	1/4
730	42 1/16	42 3/16	44	44 1/8	7/16	20	2	17 15/16	18	18 7/16	18 1/2	1/4
805	45 11/16	45 13/16	47 5/8	47 3/4	7/16	24	2	19 7/16	20	21 15/16	22	1/4
890	50 13/16	51 1/16	52 3/4	53	7/16	24	2	21 1/8	21 11/16	23 5/8	23 11/16	1/4
980	55 3/16	55 7/16	57 1/8	57 3/8	7/16	24	2	22 13/16	23 3/8	25 5/16	25 3/8	1/4
1085	60 7/16	60 11/16	62 3/8	62 5/8	7/16	28	2	24 7/8	24 15/16	27 3/8	27 7/16	1/4
1200	67 1/16	67 5/16	69	69 1/4	9/16	32	2	27 5/8	28 1/16	29 5/8	29 11/16	1/4
1320	73 5/16	73 5/16	75 1/4	75 1/4	9/16	36	2	31 15/16	32	32	32	1/4
1460	80 5/16	80 5/16	82 1/4	82 1/4	9/16	40	2	34 11/16	34 11/16	34 11/16	34 11/16	1/4
1615	90 5/16	90 5/16	92	92	9/16	44	2	37 3/8	—	37 3/8	—	1/4
1780	98 9/16	98 9/16	100 1/4	100 1/4	9/16	48	2	40 9/16	—	40 9/16	—	1/4
1965	107 9/16	107 9/16	109 1/4	109 1/4	9/16	52	2	44 1/8	—	44 1/8	—	1/4
2175	118 1/16	118 1/16	119 3/4	119 3/4	9/16	56	2	50 3/16	—	50 3/16	—	1/4

CLASS I & II, SGL. & DBL. OUTLET FLANGE



OUTLET FLANGE CANNOT BE FURNISHED FOR DOWNBLAST OR BOTTOM ANGULAR DOWN DISCHARGES IN ALL SIZES AND TOP ANGULAR DOWN DISCHARGE, DOUBLE INLET, SIZES 365 TO 540.

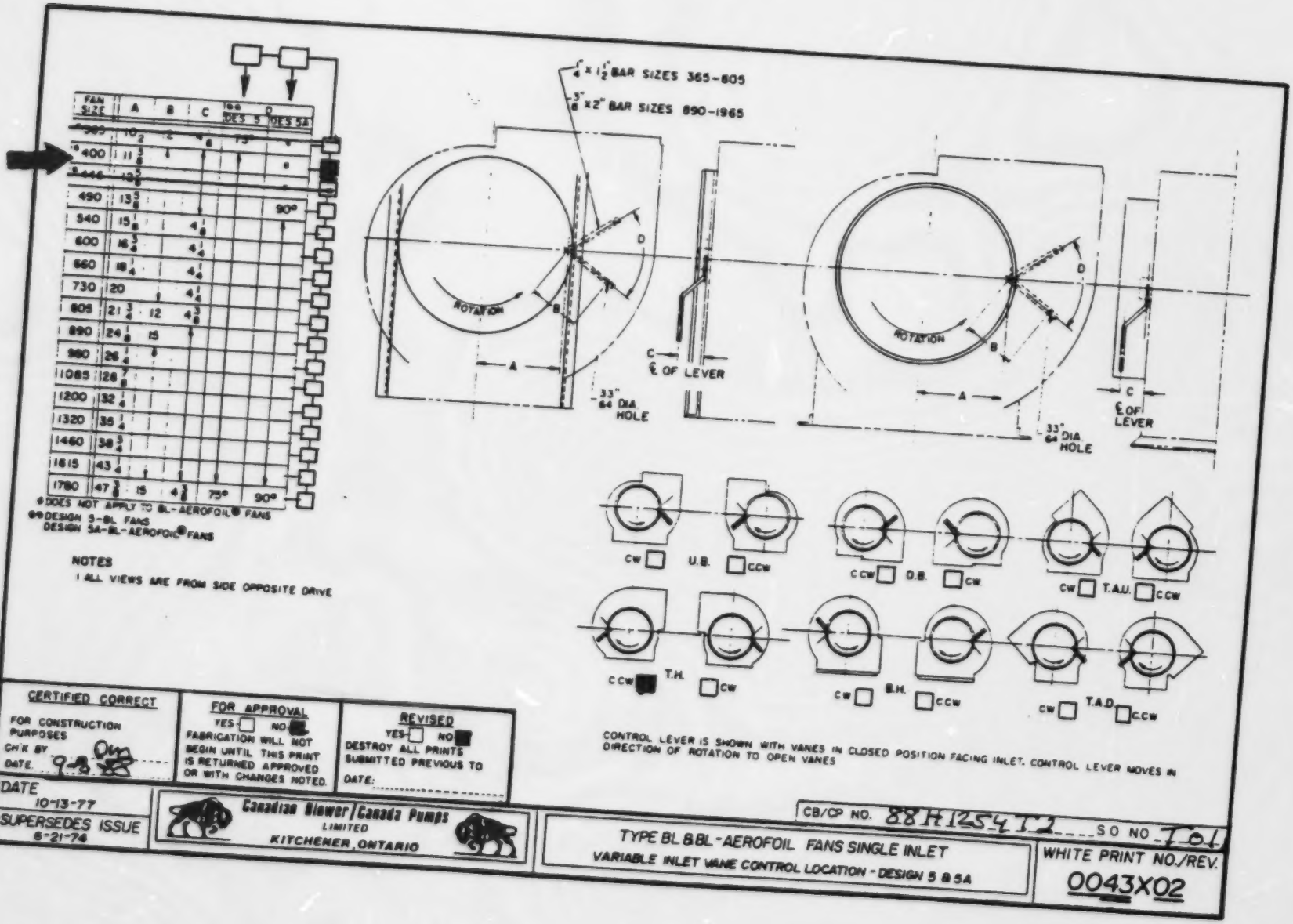
SIZE	B		BB		C	CC	K	L		M	P	T	X
	SGL.	DBL.	SGL.	DBL.				STD.	ANG.				
245	9 5/8	—	3	—	13 3/8	3	7/8	10 5/8	13 1/16	7/16	1 1/2	3/16	6 3/4
270	10 5/8	—	3	—	14 3/4	3	7/8	11 1/2	13 1/16	7/16	1 1/2	3/16	7 3/8
300	11 3/4	—	3	—	16 3/8	3	7/8	12 3/8	13 1/16	7/16	1 1/2	3/16	8 1/4
330	13	—	3	—	18	4	7/8	13 1/2	13 1/2	7/16	1 1/2	3/16	9
365	14 1/4	25 1/2	4	8	19 7/8	4	7/8	14 7/8	15 7/8	7/16	1 1/2	3/16	9 7/8
400	15 5/8	28	4	8	21 3/4	4	7/8	15 7/8	15 7/8	7/16	1 1/2	3/16	10 7/8
445	17 3/8	31 1/8	4	8	23 7/8	4	7/8	17 3/8	17 3/8	7/16	1 1/2	3/16	12 1/16
490	19 1/8	34 1/4	5	8	26 5/8	5	7/8	18 7/8	18 7/8	7/16	1 1/2	3/16	13 3/8
540	21 1/8	37 3/4	5	8	29 1/4	6	7/8	20 2	20 2	7/16	1 1/2	3/16	14 3/4
600	23 3/8	41 7/8	6	8	32 1/2	6	1 1/8	21 1/2	21 1/2	7/16	2	3/16	16 3/8
660	25 3/4	46	6	10	35 3/4	7	1 1/8	25 1/2	23 3/4	7/16	2	3/16	18
730	28 3/8	50 7/8	7	11	39 1/2	8	1 1/8	28	25 3/4	7/16	2	3/16	19 7/8
805	31 1/4	56	7	12	43 1/2	9	1 1/8	30 1/2	29 3/4	7/16	2	1/4	22
890	34 5/8	62	7	13	48 1/8	10	1 1/8	33 1/4	32 3/4	7/16	2	1/4	24 1/4
980	38	68 1/4	8	15	53	11	1 1/8	36 1/2	36 1/2	7/16	2	1/4	26 3/4
1085	42 1/8	75 1/2	9	16	58 5/8	12	1 1/8	40 1/2	40 1/2	7/16	2	1/4	29 1/2
1200	46 5/8	83 9/16	10	18	64 7/8	13	1 1/8	44 8	44 1/2	9/16	2 1/2	1/4	32 3/4

NOTE:
SEE SPECIFIC FAN WHITE PRINT FOR STANDARD INLET AND OUTLET CONSTRUCTION.

CERTIFIED CORRECT	FOR APPROVAL YES ☐ NO ■	REVISED YES ☐ NO ■	DRAWN OCT 21/63	CB/CP NO. 88F254T2	SHOP ORDER NO. T01	REF. NO. F - 1589
FOR CONSTRUCTION PURPOSES	FABRICATION WILL NOT BEGIN UNTIL THIS PRINT IS RETURNED	DESTROY ALL PRINTS SUBMITTED PREVIOUS TO:	Canadian Blower/Canada Fans LTD	BL-AEROFOIL® FANS		WHITE PRINT NO. / REV.
CH'K [redacted]	[redacted]	DATE [redacted]	[redacted]	[redacted] ANGLE [redacted] INNE[redacted] S [redacted] SPECIAL [redacted] IND [redacted] INL[redacted]		03 [redacted] 6
DATE [redacted]						

41

91-74



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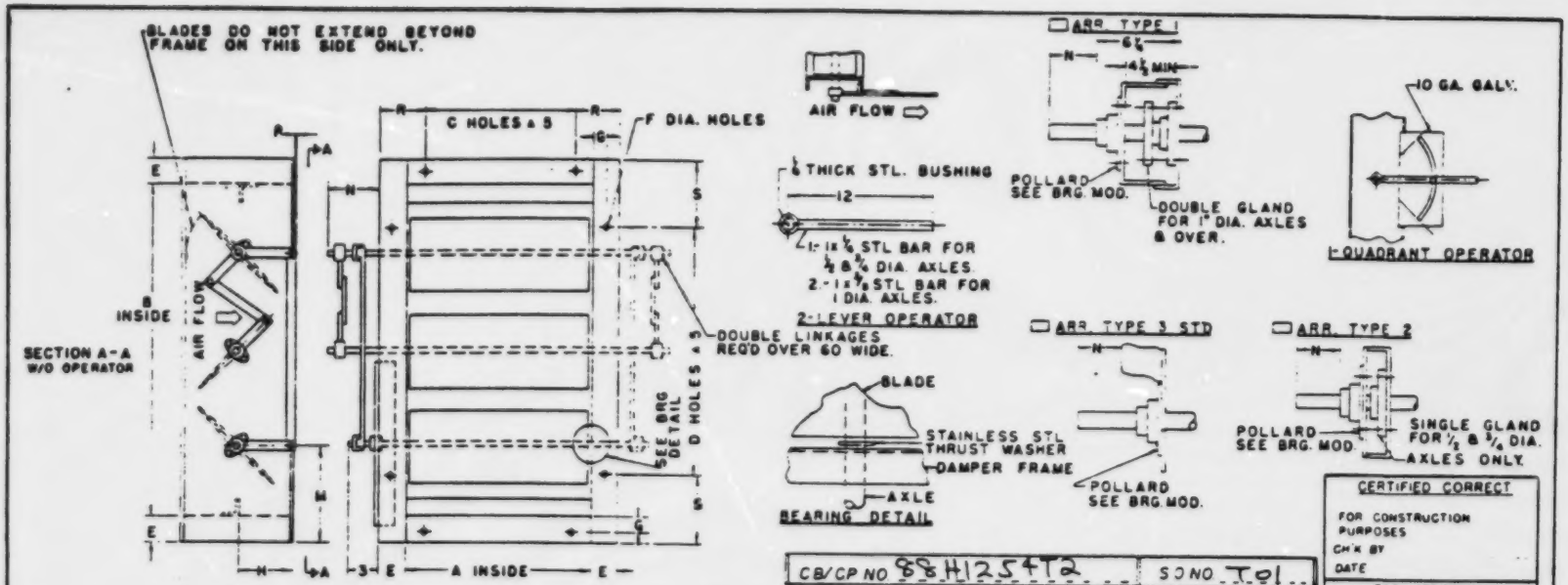
BLADES DO NOT EXTEND BEYOND FRAME ON THIS SIDE ONLY.
C HOLES @ S
F DIA. HOLES
SECTION A-A W/O OPERATOR
AIR FLOW
INSIDE
DOUBLE LINKAGES REQD OVER 60 WIDE.
SEE BRG DETAIL
D HOLES @ S
AIR FLOW
6 THICK STL. BUSHING
1 - 1 x 5/8 STL BAR FOR 1/2 & 5/8 DIA. AXLES
2 - 1 x 5/8 STL BAR FOR 1 DIA. AXLES.
2-LEVER OPERATOR
ARR TYPE 1
POLLARD SEE BRG. MOD.
DOUBLE GLAND FOR 1" DIA. AXLES & OVER.
10 GA. GALV.
QUADRANT OPERATOR
ARR TYPE 3 STD
POLLARD SEE BRG. MOD.
ARR. TYPE 2
POLLARD SEE BRG. MOD.
SINGLE GLAND FOR 1/2 & 5/8 DIA. AXLES ONLY
BLADE
STAINLESS STL THRUST WASHER
DAMPER FRAME
AXLE
BEARING DETAIL

CB/CP NO 88H125+T2 SO NO T01

REF DWG SD-7937

ITEM	FAN SIZE	NO. BLADE	A	B	C	D	E	F	G	H	M	N	P	R	S	ARR TYPE	GA FR	GA BLADE	AXLE DIA.	BRG. MOD
1	245	1	13 1/2	9 3/4	3	3	1 7/16	7/16	13/16	5	6 5/16	4 1/2	2 1/2 max	3 5/16	1 5/16	12 GALV	16 GALV	3/4 STL	SLFL
2	270	1	14 7/8	10 3/4	3	3	"	"	"	4 3/4	6 13/16	"	"	3 7/8	1 13/16	"	"	"	"
3	300	2	16 1/2	11 7/8	3	3	"	"	"	5	4 13/16	"	"	4 11/16	2 3/8	"	"	"	"
4	330	2	18 1/8	13 1/8	4	3	"	"	"	5	5 1/8	"	"	3	3	"	"	"	"
5	365	2	20	14 3/8	4	4	"	"	"	5	5 3/8	"	"	3 15/16	1 1/8	"	"	"	"
6	400	2	21 7/8	15 3/4	4	4	"	"	"	5	5 13/16	"	"	4 7/8	1 13/16	"	"	"	"
7	445	2	24 1/2	17 1/2	5	4	"	"	"	5	6 5/16	"	"	3 15/16	2 11/16	"	"	"	"
8	490	2	25 3/4	19 1/4	5	5	"	"	"	4 7/8	6 5/8	"	"	4 13/16	1 1/16	"	"	"	"
9	540	2	29 3/8	21 1/4	6	5	1 7/16	"	13/16	4 1/2	7 3/16	"	"	3 5/8	2 1/16	"	"	"	"
10	600	3	32 3/8	23 1/2	6	6	1 15/16	"	1 1/16	5	6 7/16	"	"	5 3/4	1 3/16	"	"	"	"
11	660	3	35 7/8	25 7/8	7	6	"	"	"	5	6 3/4	"	"	4 7/8	2 5/8	"	"	3/4 STL	"
12	730	3	39 3/4	28 1/2	8	7	"	"	"	4 3/4	7 3/16	"	"	4 1/4	1 3/16	12 GALV	"	1 STL	"
13	805	4	43 3/8	31 3/8	9	7	"	"	"	5	6 5/16	"	"	3 3/4	2 5/8	10 GALV	"	1 STL	SLFL
14	890	4	48 1/4	34 3/4	10	7	"	"	"	5	6 15/16	"	"	3 9/16	4 5/16	"	"	1 1/4 STL	SFT
15	980	4	53 1/8	38 1/8	11	8	"	"	"	4 3/4	7 5/16	"	"	3 1/2	3 1/2	10 GALV	16 GALV	"	"
16	1085	4	58 3/4	42 1/4	12	9	1 15/16	7/16	1 1/16	4 1/4	7 7/8	"	"	3 13/16	3 13/16	3/8 GALV	10 GALV	1 1/4 STL	"
17	1200	5	64 7/8	46 3/8	13	10	2 7/16	9/16	1 3/16	4 3/4	7 3/4	4 1/2	2 1/2 max	4 7/8	3 1/4	3/8 GALV	16 GALV	1 1/2 STL	SFT

FAN SIZE	0 - 450 MANUAL LEVER PAR	OPP	PAR	OPP
245	1A	1B	1C	1D
270	2A	2B	2C	2D
300	3A	3B	3C	3D
330	4A	4B	4C	4D
365	5A	5B	5C	5D
400	6A	6B	6C	6D
445	7A	7B	7C	7D
490	8A	8B	8C	8D
540	9A	9B	9C	9D
600	10A	10B	10C	10D
660	11A	11B	11C	11D
730	12A	12B	12C	12D
805	13A	13B	13C	13D
890	14A	14B	14C	14D
980	15A	15B	15C	15D
1085	16A	16B	16C	16D
1200	17A	17B	17C	17D

CERTIFIED CORRECT
FOR CONSTRUCTION PURPOSES
CH'K BY
DATE

FOR APPROVAL
YES ☐ NO ☐
FABRICATION WILL NOT BEGIN UNTIL THIS PRINT IS RETURNED APPROVED OR WITH CHANGES NOTED

REVISED
YES ☐ NO ☐
DESTROY ALL PRINTS SUBMITTED PREVIOUS TO
DATE

SPECIFICATIONS

1. MOUNTING HOLES TO BE PROVIDED IN BOTH FLANGES.
2. OPPOSITE BLADES SHOWN PARALLEL BLADES AVAILABLE
3. FINISH: SILVER-BRITE HI-HEAT RESISTING ALUM.
4. QUADRANT SUPPLIED FOR MANUAL OPERATION.
5. LEVER OPERATOR SUPPLIED FOR AUTOMATIC OPERATION.
6. ARR. TYPE 3 SHOULD BE USED FOR STD AIR STREAM.
7. ARR. TYPES 1 & 2 SHOULD BE USED WHENEVER THERE IS A CONTAMINATED AIR STREAM.

DATE 2-18-77
SUPERSEDES ISSUE OF 4-23-76

Canadian Blower/Canada Pumps LIMITED
KITCHENER, ONTARIO

OUTLET DAMPER - WITH PARALELL & OPPOSED BLADES
DESIGN 9-10"-12" W.G. STATIC PRESSURE TYPE "BL" FAN - (SINGLE INLET)

WHITE PRINT NO. / REV.
0 203 X 02

0203 x 02

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91-74

APPENDIX III

MANUALS (HYGROMETER AND PRESSURE TRANSDUCER)

rotronic
instrument corp

CALIBRATION INSTRUCTIONS

ALPHA
CONTROLS AND INSTRUMENTATION

361 Steelcase Rd. West, Unit 3, Markham, Ontario, Canada L3R 3V8
Tel: (416) 477-2133 Fax: (416) 477-4219 Telex: 06-986761

This manual is valid for both humidity and humidity-temperature instruments of the ROTRONIC HYGROMER line. In the case of instruments measuring humidity only, please disregard any reference to temperature calibration.

To access the adjustment potentiometers, open the case of the unit. See the instruction manual of each individual instrument for the location of the different adjustment potentiometers.

A) HUMIDITY CALIBRATION

IMPORTANT

. STABILITY OF TEMPERATURE DURING CALIBRATION IS EXTREMELY CRITICAL:

DO NOT CALIBRATE UNLESS TEMPERATURE STABILITY IS +/- 0.4 F OR BETTER DURING THE PERIOD OF TIME REQUIRED FOR EACH CALIBRATION POINT. FOR INSTANCE, DO NOT CALIBRATE IN DIRECT EXPOSURE TO A DRAFT (AIR CONDITIONING VENT), IN DIRECT EXPOSURE TO SUNLIGHT OR CLOSE TO A HEATING ELEMENT. IF NECESSARY, SHELTER THE PROBE AND CALIBRATION DEVICE BY PUTTING THEM IN AN INSULATED BOX.

. CALIBRATION INSTRUCTIONS MUST BE FOLLOWED EXACTLY IN THE ORDER GIVEN HEREUNDER. HOWEVER, IF YOU HAVE A HUMIDITY-TEMPERATURE INSTRUMENT AND WISH TO CALIBRATE TEMPERATURE, PROCEED WITH TEMPERATURE CALIBRATION FIRST.

. ON MOST RIC HUMIDITY-TEMPERATURE INSTRUMENTS, HUMIDITY MEASUREMENT IS INTERNALLY COMPENSATED FOR TEMPERATURE, BASED ON THE OUTPUT PROVIDED BY THE TEMPERATURE MEASURING CIRCUIT. BECAUSE OF THIS, CALIBRATION OF TEMPERATURE MUST BE FOLLOWED BY A HUMIDITY CALIBRATION.

Do not calibrate your instrument against a reference instrument such as a psychrometer or a chilled mirror dew point instrument. Direct comparison between two humidity instruments can be very misleading, even if this is done under fairly stable conditions such as provided by an environmental chamber or incubator. Comparing two relative humidity instruments assumes that both temperature and humidity are stable and uniformly distributed. This assumption is seldom verified, even when the two instruments are practically in contact one with another.

1) CALIBRATION DEVICE

A RIC calibration device is a small airtight chamber that fits on the instrument probe and seals around the humidity sensor. A known reference humidity can be produced inside the calibration device to check the instrument.

Depending on the model, the calibration device is either slipped over the probe and sealed tightly with a compression fitting or it is screwed tightly on the tip of the probe after removing the slotted cap or the dust filter. See the instruction manual or the data sheet of your instrument for the model of calibration device that fits your instrument.

2) HUMIDITY STANDARDS

RIC humidity standards are used to produce a known reference humidity inside the calibration device. This process requires that the humidity standard, the air volume inside the calibration device and the humidity sensor all be at equilibrium one with another, both in temperature and humidity. Because of this requirement, calibration usually takes from 45 to 60 minutes for each value.

The RIC standards are designed to permit calibration by non-skilled personnel. RIC humidity standards are available in boxes of 5 glass ampules of the same value, which can be stored indefinitely. Standards in the range of 5 to 95 %RH are non-saturated salt solutions that are precisely titrated at our factory for the right concentration. The 0 %RH humidity standard consists in small granules of a highly porous ceramic that were dried at a high temperature. Humidity standards are described in more detail in a separate Material Safety Data Sheet. Since most standards are a salt solution, metal parts which have come in contact with the liquid should be cleaned after each use.

As an alternative to the RIC humidity standards, you may prepare and use your own saturated salt solutions. This is more complicated and, therefore, less convenient than using the RIC standards. The use of saturated salt solutions should be confined to a calibration laboratory and limited to trained personnel. When using saturated salt solutions, follow the procedure described in ASTM standard # E 104-85. Pay attention to the fact that some salts produce heat when mixed with water. Allow for up to 24 hours to obtain temperature equilibrium.

The reference humidities values obtained at equilibrium above saturated salt solutions can be found in ASTM standard # E 104-85. These values are reproduced from a 1977 publication by L. Greenspan of the National Bureau of Standards. Because of the assurance that the NBS publication provides, you should use saturated salt solutions whenever you must report calibration data to a third party such as a regulatory agency (Food and Drug Administration or other). Compared to the values published by the N.B.S. for saturated salt solutions, the RIC humidity standards are manufactured to a maximum tolerance of 0.5%RH.

3) CALIBRATION PROCEDURE

CALIBRATE HUMIDITY AT A STABLE TEMPERATURE CLOSE TO 75 F (NORMAL ROOM TEMPERATURE).

a) Adjustment with the 35 %RH Potentiometer:

THE FIRST CALIBRATION ADJUSTMENT MUST BE AT 35 %RH OR AT A VALUE CLOSE TO THAT.

. Set the 80% potentiometer in mid position.

. Unscrew the knurled receptacle of the calibration device.

. Install the calibration device on the probe of your instrument and seal tightly.

. Place one fibre disc (each box of RIC humidity standards includes 5 discs) in the receptacle of the calibration device. The purpose of this disc is to prevent accidental spilling of the solution inside the calibration device or on the humidity sensor.

. Tap the top of one ampule of 35 %RH solution so that all liquid drops to the bottom of the ampule. Snap off top and empty contents on fibre disc. SINCE THE AMPULE IS MADE OF GLASS, EXERCISE PROPER CAUTION (GLOVES, SAFETY GLASSES) WHEN SNAPPING OFF THE TOP.

. Put the knurled receptacle back on the calibration device and make sure that the solution does not come in contact with the sensor: THE SOLUTION INSIDE THE CALIBRATION DEVICE SHOULD NEVER BE ON TOP OF THE SENSOR.

. Allow at least 45 minutes to insure that the calibration device, the solution and the sensor are in a state of equilibrium. This is verified by monitoring the output or display of the instrument.

. At equilibrium (stable output signal), adjust the 35% potentiometer so that the unit reads 35 %RH.

. Remove the knurled receptacle from the calibration device. Throw away the wet disc (non reusable). THOROUGHLY WIPE DRY THE RECEPTACLE WITH A SOFT TISSUE, REMOVING ALL TRACES OF LIQUID. IT IS IMPORTANT TO AVOID CONTAMINATION OF SOLUTIONS SUBSEQUENTLY USED IN THE CALIBRATION DEVICE.

b) Adjustment with the 80 %RH Potentiometer:

USE 80 %RH AS THE SECOND CALIBRATION VALUE AS THIS PROVIDES THE BEST OVERALL ACCURACY OVER THE FULL RANGE OF MEASUREMENT. IF MORE APPROPRIATE FOR A SPECIFIC APPLICATION, YOU MAY USE ANY OTHER HUMIDITY VALUE ABOVE 35 %RH.

. Repeat the procedure used for the 35 %RH adjustment with an 80 %RH standard. Allow at least 60 min. for equilibrium.

. At equilibrium, adjust the unit with the 80% potentiometer so that it reads 80 %RH.

. Remove the calibration device from the probe and thoroughly clean the receptacle.

This completes the basic humidity calibration procedure of the instrument. This procedure is sufficient to obtain the specified accuracy from 0 to 100 %RH.

note: If the second calibration value is higher than 80 %RH, allow for more time (at least 2-3 hours) and provide tighter temperature stability during calibration (at 95 %RH, a difference of 0.2 F between the sensor and calibration device or solution already results in 0.6 %RH error).

c) Adjustment at low humidity:

Your unit may be equipped with two additional calibration potentiometers for humidity. These are used to enhance accuracy in the range of 0 to 35 %RH. The procedure to be followed is similar to the one used at 35 and 80 %RH.

. Calibrate your instrument at 35 %RH and 80 %RH.

. Adjust the low humidity reading with the 10% potentiometer. The reference humidity may be given by an EA05, EA10, EA20 or by a saturated solution of Lithium-Chloride (11.3 %RH @ 25C).

. The 0 %RH reading is adjusted with the 0% potentiometer. The reference humidity may be given by an EA00 standard. Equilibration usually requires about one hour to achieve good precision.

B) TEMPERATURE CALIBRATION

Both the Pt 100 RTD temperature sensor and the electronics are very stable and should not require any calibration after the initial factory adjustment.

TEMPERATURE CALIBRATION REQUIRES EQUIPMENT THAT IS USUALLY NOT AVAILABLE IN THE FIELD. IF A TEMPERATURE CALIBRATION IS REQUIRED, THE INSTRUMENT SHOULD PREFERABLY BE RETURNED TO RIC.

1) CALIBRATION METHOD

Temperature calibration can be done in two different manners:

Calibration by substitution:

The Pt100 RTD is removed from the probe and replaced by a decade box that simulates the resistance of the RTD at different temperatures. This permits adjustment of the electronics at two different simulated temperatures.

The Pt100 RTD is put back on the probe and the complete unit is checked at room temperature with a precision thermometer placed at close proximity to the Pt100 RTD. Both the thermometer and the probe being calibrated must be ventilated. If a slight adjustment is required, this is done with the T min potentiometer.

Direct Calibration:

When using this method, calibration is done in reference to a precision thermometer for which calibration data is available. Both the reference thermometer and the probe of the instrument to be calibrated are immersed in a temperature controlled water bath. It is very critical to conform to the immersion depth recommended for the thermometer. The probe of the instrument to be calibrated must be as fully immersed in the bath as possible. Before immersing the probe, make sure that the humidity sensor is protected from the liquid of the bath. This can be done by putting a membrane or a foam filter (available from RIC) on the probe.

The bath temperature must be very stable and uniform during calibration. At equilibrium (at least 30 minutes), the instrument output or display is adjusted against the reading of the reference thermometer. This procedure is repeated at two temperatures.

WE DO NOT RECOMEND A DIRECT TEMPERATURE CALIBRATION IN AIR OR ANY OTHER GAS.

2) CALIBRATION PROCEDURE

Whatever method is being used, temperature calibration must be done according to the following sequence:

a) Low Temperature Adjustment:

THIS MUST BE DONE AT 0 C OR 32 F.

. Position the T max potentiometer at the middle of its span.

. Adjust the temperature output or display of the instrument with the T min potentiometer so that it reads 0 C or 32 F. The T min potentiometer adjusts the zero of the temperature measuring bridge.

b) High Temperature Adjustment:

PREFERABLY, THIS SHOULD BE DONE AT A TEMPERATURE NEAR THE UPPER END OF THE MEASURING RANGE OF THE INSTRUMENT. HOWEVER, IN THE CASE OF UNITS MEASURING UP TO 150 C OR 300 F, USE A TEMPERATURE CLOSE TO 100 C OR 212 F.

. Adjust the temperature output or display with the T max potentiometer so that it reads the reference temperature. The T max potentiometer adjusts the span or amplification of the temperature measuring circuit.

PROCEED TO HUMIDITY CALIBRATION

SETRA SYSTEMS, INC. PRESSURE TRANSDUCERS AND TRANSMITTERS

Model 264/C-264

VERY LOW DIFFERENTIAL PRESSURE

Ranges: 0 0 1 to 0 25 in H O
0- ± 0 1 to 0- ± 5 in H O
Air or non-conducting gas

Benefits

- Minimize installation time with snap track mounting and easy to reach plumbing and electrical connections.
- Eliminate field range adjustment with NBS traceable factory calibration.
- 0 to 5 VDC or 2-wire 4 to 20 mA analog outputs are compatible with your Building Automation System.
- Fully protected against damage due to incorrect wiring.
- Internal regulation permits use with unregulated DC power supplies.
- 1% accuracy improves variable air volume system performance.

Description

The Setra Systems Series 264 senses differential or gage (static) pressures and converts this pressure difference to a proportional electrical output for both unidirectional and bidirectional pressure ranges. The 264 Series is offered in two versions: the Model 264 Pressure Transducer with a 0 to 5 VDC output and the Model C-264 Pressure Transmitter with a 2-wire, 4 to 20 mA output.

Used in Building Energy Management Systems (with correctly sized and installed mechanical equipment), these transducers and transmitters are capable of measuring pressures and flows with the accuracy necessary for proper building pressurization and air flow control.

The 264 Series very low pressure transducers and transmitters are available for air pressure ranges as low as 0.1 in. H_2O full scale to 25 in. H O full scale. Static accuracy is ± 1% full scale in normal ambient temperature environments. The units are temperature compensated to less than ± 0.033% FS/°F of thermal error over the temperature range of 40°F to 100°F.

Applications

- Heating, Ventilating and Air Conditioning (HVAC)
- Energy Management Systems
- Variable air volume and fan control (VAV)
- Environmental pollution control
- OEM
- Static duct and clean room pressures
- Oven Pressurization and Furnace Draft Controls
- Medical instrumentation

Construction

Setra's variable capacitance sensors approach the ultimate in design simplicity. A stainless steel diaphragm, formed in a patented configuration, and an insulated electrode positioned close to the diaphragm form a variable capacitance. Positive pressure moves the diaphragm toward the electrode, increasing the capacitance. Negative pressure moves the diaphragm away from the electrode, decreasing the capacitance. The capacitance is detected and converted to a linear DC electrical signal by Setra's unique electronic circuit. The sensor is enclosed in a welded stainless steel body, providing excellent long term stability.

ALPHA
CONTROLS AND INSTRUMENTATION

361 Steelcase Rd. West, Unit 3, Markham, Ontario, Canada L3R 3V8
Tel: (416) 477-2133 Fax: (416) 477-4219 Telex: 06-986761

91-74

45 Nagog Park, Acton, Massachusetts 01720/ Telephone 1-800-25-SETRA. In MA (617) 263-1400

setra

Model 264/C-264 Specifications

Pressure Ranges and Media

Unidirectional	0 to 0.1, 0.25, 0.5, 1.0, 2.5, 5.0, 10.0, 25.0 in. H_2O
Bidirectional	0 to ±0.1, ±0.25, ±0.5, ±1.0, ±2.5, ±5.0 in. H_2O
Pressure Media	Typically air or similar non-conducting gases.
Maximum Line Pressure	25 in. H_2O Gage
Overpressure	5 × Full Scale (either direction) or 10 in. WC (whichever is greater).

Accuracy Data

Accuracy*	< ± 1.0% full scale (best straight line)
Resolution	Infinite
Repeatability	<0.3% FS
Thermal Effects	< ± 0.033%FS/°F over 40°F to 100° F range. Calibrated at 70°F.

Position Effect (Unit is factory-calibrated at 0g effect with diaphragm vertical)	Range	Zero Offset (%FS/G)
	0 to 10 in. H_2O	0.3
	0 to 1.0 in. H_2O	1
	0 to 0.1 in. H_2O	4

*Combines non-linearity, hysteresis, and non-repeatability

Environmental and Mechanical Data

Temperature	0 to 175°F operating; −65°F to 250° storage
Case	Fire-retardant glass filled polyester
Mounting	Four screw holes on removable stainless steel base. Designed for 2.75 in. snap track
Pressure Connections	3/16" O.D. barbed brass pressure fitting for 1/4" push-on tubing. Positive and reference port on top
Weight (approx.)	10 ounces
Electrical Connections	Screw terminal strip on top of case.

Ordering Information

Order as Model 264 pressure transducer for a 0 to 5 VDC output
Order as a C-264 pressure transmitter for a 4 to 20mA output
Specify: Differential pressure range

U.S. Patent Nos. 3646539, 3775719, Re.30603, 4093915, 4358814, 4434203
Canada Patented (Brevete) 1974, 1975, 1976, 1979
Other foreign patents pending

Specifications subject to change without notice.

Electrical Data

Voltage Output (Model 264)

The Model 264 is a three wire circuit (+ in, + out, common) with 0-5 VDC output

Output Voltage	
Unidirectional Pressure	0 to 5 VDC nominal
Bidirectional Pressure	0 to 5 VDC nominal, with zero pressure output at 2.5 VDC
Excitation	Can operate from 12VDC to 28 VDC, unregulated, < 10 milliamperes
Zero and Span Adjusts	Accessible on top of case
Output Impedance	< 100 Ohms

Current Output (Model C-264)

The C-264 has a true 2-wire, 4 to 20 milliampere (a 16 mA output span) output circuit which delivers rated current into any external load between 0 and 800 ohms.* Designed to meet ISA-S50.1 (1975) standard "Compatibility of Analog Signals for Electronic Industrial Process Instruments," Type and Class 2U (Universal) within the following parameters:

- Minimum supply voltage (VDC) = 15 + 0.02 × (Resistance of receiver plus line)
- Maximum supply voltage (VDC) = 32 + 0.004 × (Resistance of receiver plus line)

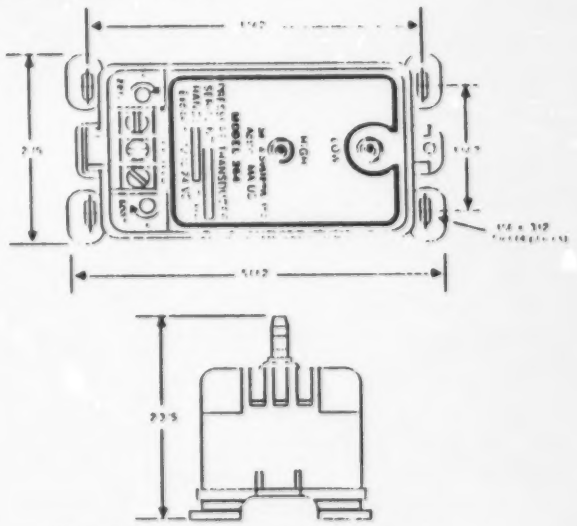
Variations in the power supply voltage cause less than 0.02 mA change in the transmitter's current output per volt change in the power supply.

Reverse excitation will not damage circuit.

Zero and Span Adjusts: Accessible on top of case.

*Calibrated at factory using a 250 ohm load at 24 VDC.

Outline Drawing



Note: All dimensions are shown in inches.

91-74
setra
45 Nagog Park, Acton, Massachusetts 01720/Telephone 1-800-257-3872. In MA (617) 263-1400

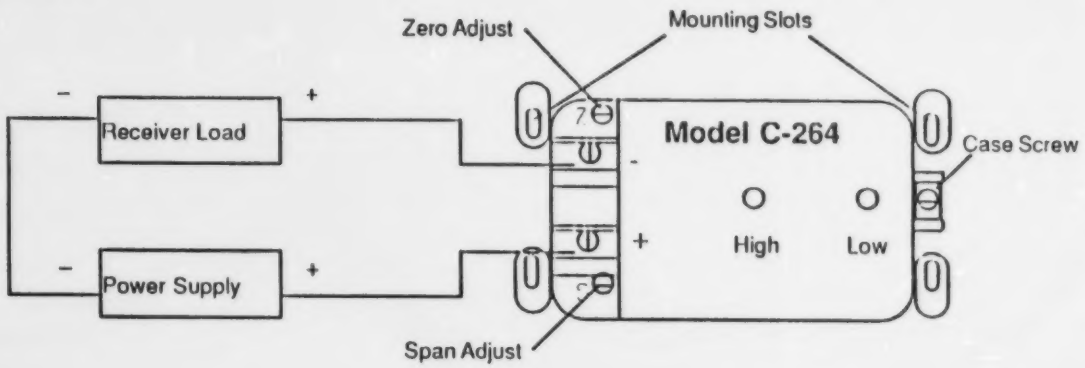
Setra Systems 264 Series
Low Pressure Transducers and Transmitters
Installation Guide

The Setra Systems 264 series pressure transducers and transmitters sense differential or gage (static) pressure and convert this pressure difference to a proportional high level analog output for both unidirectional and bidirectional pressure ranges. Two versions are offered: the Model 264 transducer with 0 to 5 VDC output and the Model C-264 transmitter with 4 to 20 mA output.

Electrical Connections:

Model 264:	+ EXC.	Connect to positive terminal of 12-24 VDC Power Supply
	+ OUT	Connect to positive terminal of Control or Pressure Monitor
	COMMON	Connect as Common Return Leads for +EXC. and +Out (to negative terminals of power supply and control or pressure monitor)

Model C-264:



Mounting: The 264 series is designed for mounting in either 2.75" snap-track or by using the four (4) slots (suitable for #6 screws) that are provided on the plate. Optimum performance is obtained by isolating the instrument from vibration and providing relatively clean, dry ambient air to the pressure ports.

Note: Even though there is no flow through the 264 series, a filter is located in both the high and low pressure ports for use in extreme dust or moisture conditions.

In most cases, preferred installation is with the baseplate mounted vertically and located on a relatively flat surface in a junction box or attached to a nearby beam. Easy field replacement is possible by removing the single case screw that holds the black sensor/circuit housing to the baseplate and lifting the black housing free. The baseplate remains mounted and can be used with the replacement unit's black sensor/circuit housing.

Caution: The axis most sensitive to vibration is the one perpendicular to the baseplate. Avoid mounting with maximum vibration along this axis.

Piping: Two (2) 3/16" O.D. barbed pressure fittings are supplied for pressure signal connection with 1/4" push-on tubing. Both the positive (high) pressure port and the reference (low) pressure port are located on the top face of the unit. For best results (shortest response times), 3/16" I.D. tubing is suggested for tubing lengths up to 100 feet long, 1/4" I.D. for tubing lengths up to 300 feet, and 3/8" I.D. for tubing lengths up to 900 feet.

Overpressure or vacuum greater than five (5) times the full scale pressure range identified on the unit's label or 10 inches of water column (whichever is greater) may damage the unit. To avoid accidental overpressure, run the tubing before attaching it, unpressurized, to the 264.

45 Nagog Park, Acton, Ma 01720/Telephone 1-800-25-SETRA In MA (617) 263-1400

SSO471 - 6/01/87

Electrical: Wiring terminations are identified on the label on top of the unit.

The **Model 264** is a three (3) wire circuit (+EXC, + OUT, COMMON) with 0 to 5 VDC output requiring 12 to 24 VDC unregulated power.

The **Model C-264** is a two (2) wire circuit (+ SUPPLY, - RECEIVER) with 4 to 20 mA output. The unit is calibrated at the factory using a 250 ohm load, at 24 VDC.

Notes:
Minimum Supply Voltage (VDC) = 15 + 0.02 X (resistance of receiver plus line)
Maximum Supply Voltage (VDC) = 32 + 0.004 X (resistance of receiver plus line)
If the current loop has a current limiter, threshold should be adjusted to 35 mA minimum.

Calibration: The 264 series is factory calibrated and should require no field adjustment. However, both zero and span adjustments are provided near the screw terminal strip. Whenever possible, any zero and/or span offsets should be corrected by software adjustment in the user's control system. Use the zero and span adjustments on the 264 series only if absolutely necessary. The 264 series is calibrated in the vertical position at the factory (baseplate vertical). For use in other orientations, position the unit and follow the zero adjustment procedure listed below. Pressure ranges are fixed and cannot be changed in the field. If a range change is required, contact the factory for a replacement series 264 with the appropriate pressure range.

Zero Adjustment:

Model 264: While monitoring the voltage between the positive output (+ OUT) and common (COM), and with both pressure ports open to atmosphere, the zero may be adjusted. For unidirectional pressure ranges, turn the zero adjustment screw until a reading of +0.025 VDC (+0.075/-0.025 VDC) is achieved. For bidirectional pressure ranges set zero to 2.5 VDC (+/- 0.050 VDC).

Model C-264: While monitoring the current output with both pressure ports open to atmosphere, the zero may be adjusted. For unidirectional pressure ranges, turn the zero adjustment screw until a reading of 4 mA (+/- .15 mA) is achieved. For bidirectional ranges, set the zero to12 mA (+/- .15 mA).

Span Adjustment: Complete the zero adjustment before setting span.

Model 264: Span or full scale output adjustments should only be performed by using an accurate pressure standard (electronic manometer, digital pressure gage, etc) with at least comparable accuracy to the 264 series (< +/- 1% full scale). With full scale pressure applied to the high pressure port, adjust span for full scale electrical output of 5.000 VDC (+/- 0.050 VDC).

Example 1: Unidirectional pressure range of 0 to 1" W.C.
Apply 1.00" W.C., adjust span to 5.000 VDC (+/- 0.050 VDC).

Notes: Model 264 - The input is reverse-voltage protected. The output is internally protected against damage if shorted to ground. Recheck all connections before applying power.

Model C-264: Span or full scale output adjustments should only be performed by using an accurate pressure standard (electronic manometer, digital pressure gage, etc.) with at least comparable accuracy to the 264 series (< +/- 1% full scale). With full scale pressure applied to the high pressure port (reference port open to atmosphere), adjust span to 20 mA (+/- .15 mA).

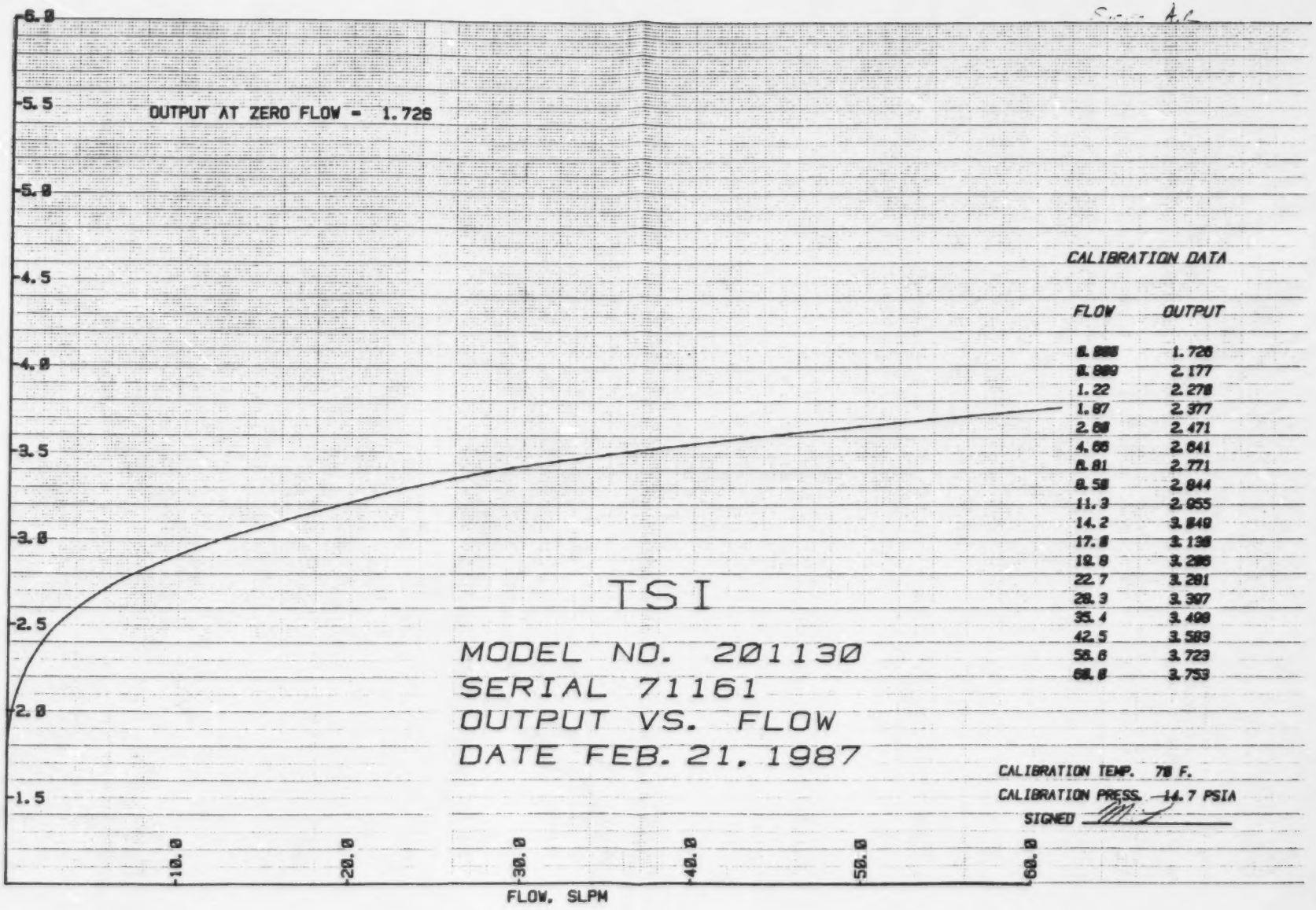
Example 1: Unidirectional pressure range of 0 to 1" W.C.
Apply 1.00" W.C., adjust span to 20 mA (+/- 0.4 mA).

Example 2: Bidirectional pressure range of +/- 1" W.C.
Apply 1.00" W.C., adjust span to 20 mA (+/- 0.4 mA).
Apply -1.00" W.C., adjust span to 4 mA (+/- 0.4 mA)

ALPHA
CONTROLS AND INSTRUMENTATION
361 Steelcase Rd. West, Unit 3, Markham, Ontario, Canada L3R 3V8
Tel: (416) 477-2133 Fax: (416) 477-4219 Telex: 06-986781

APPENDIX IV

FLOWMETER CALIBRATION CURVES FOR THE DMPS



K+E 47 1510
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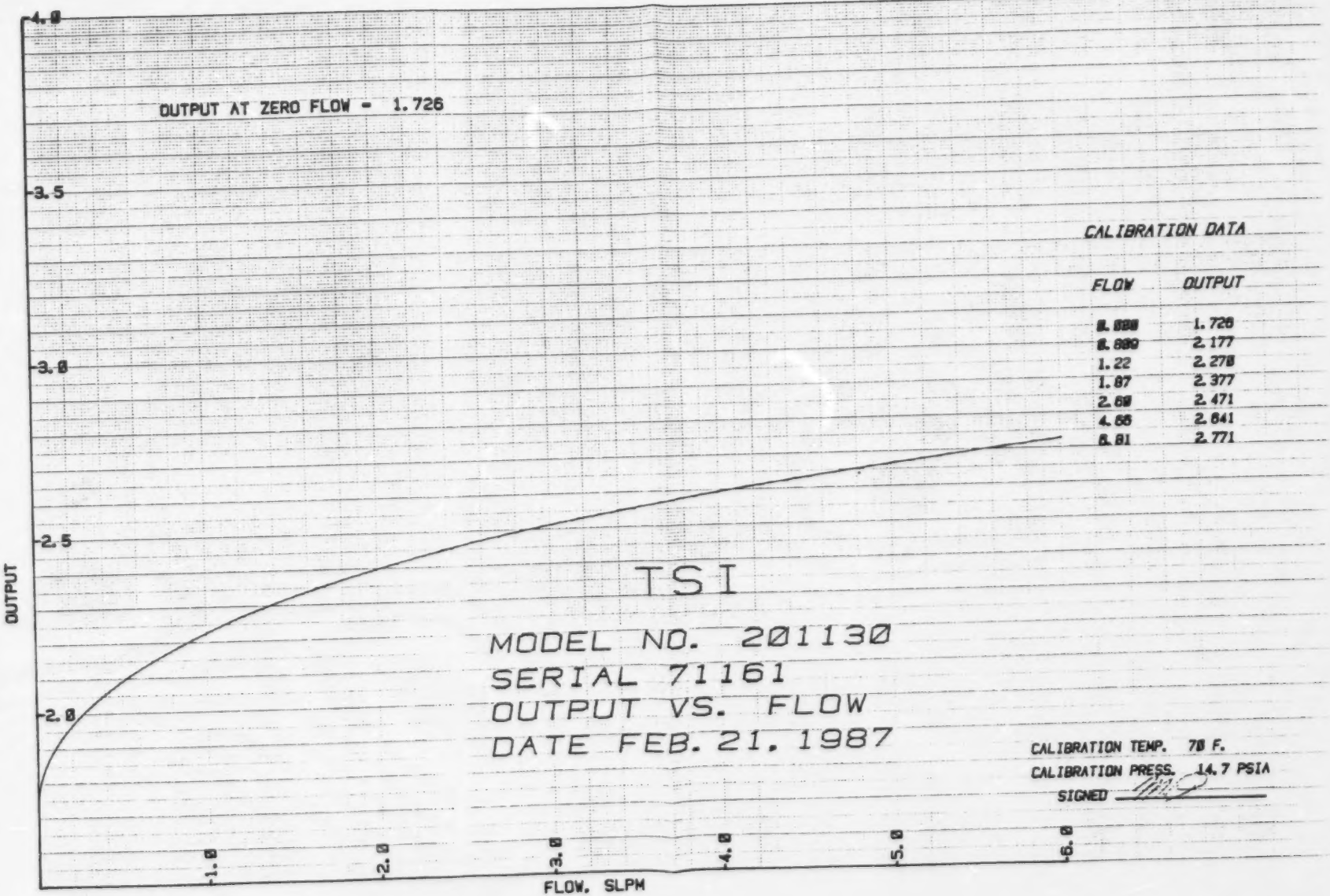
91-74



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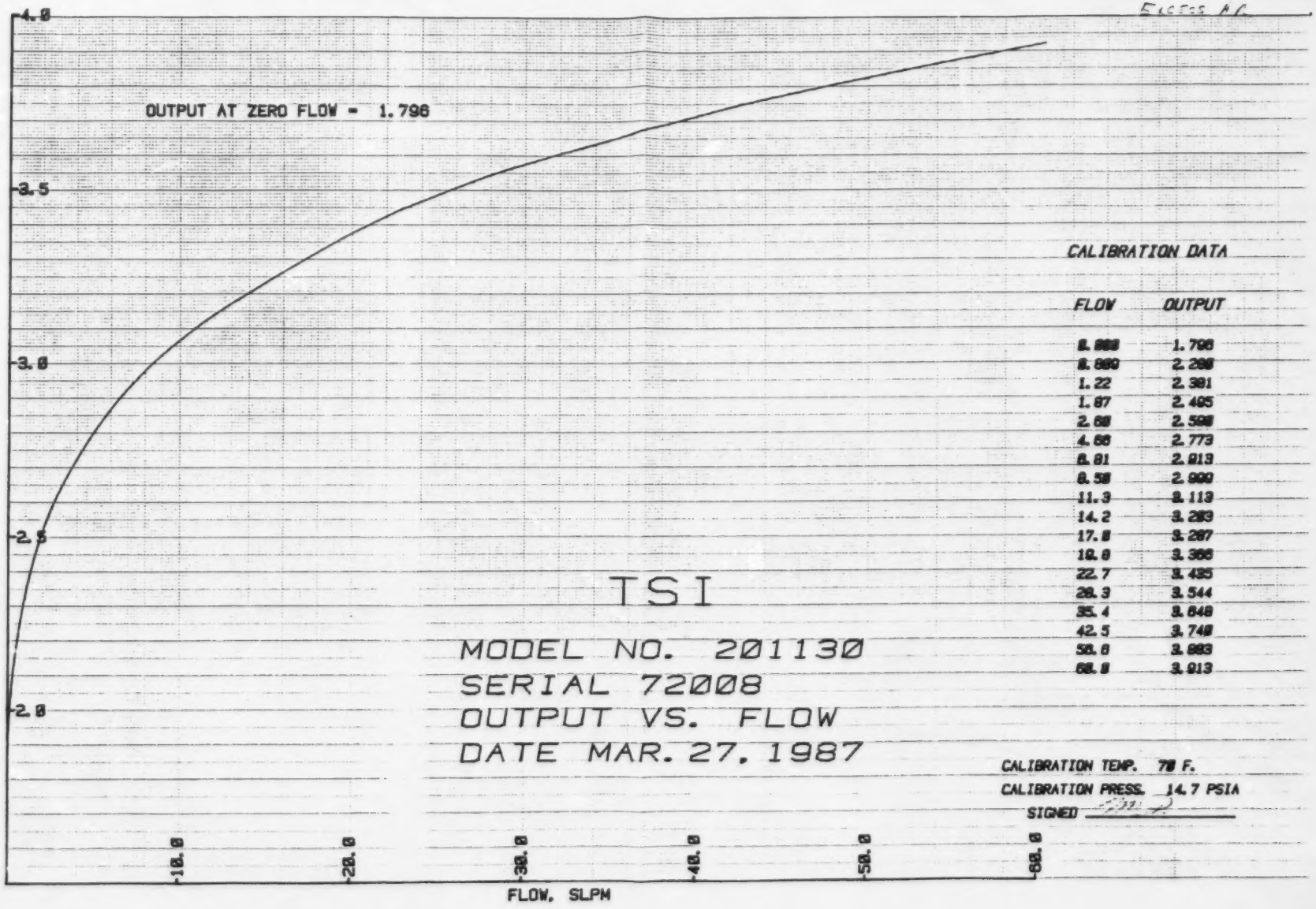

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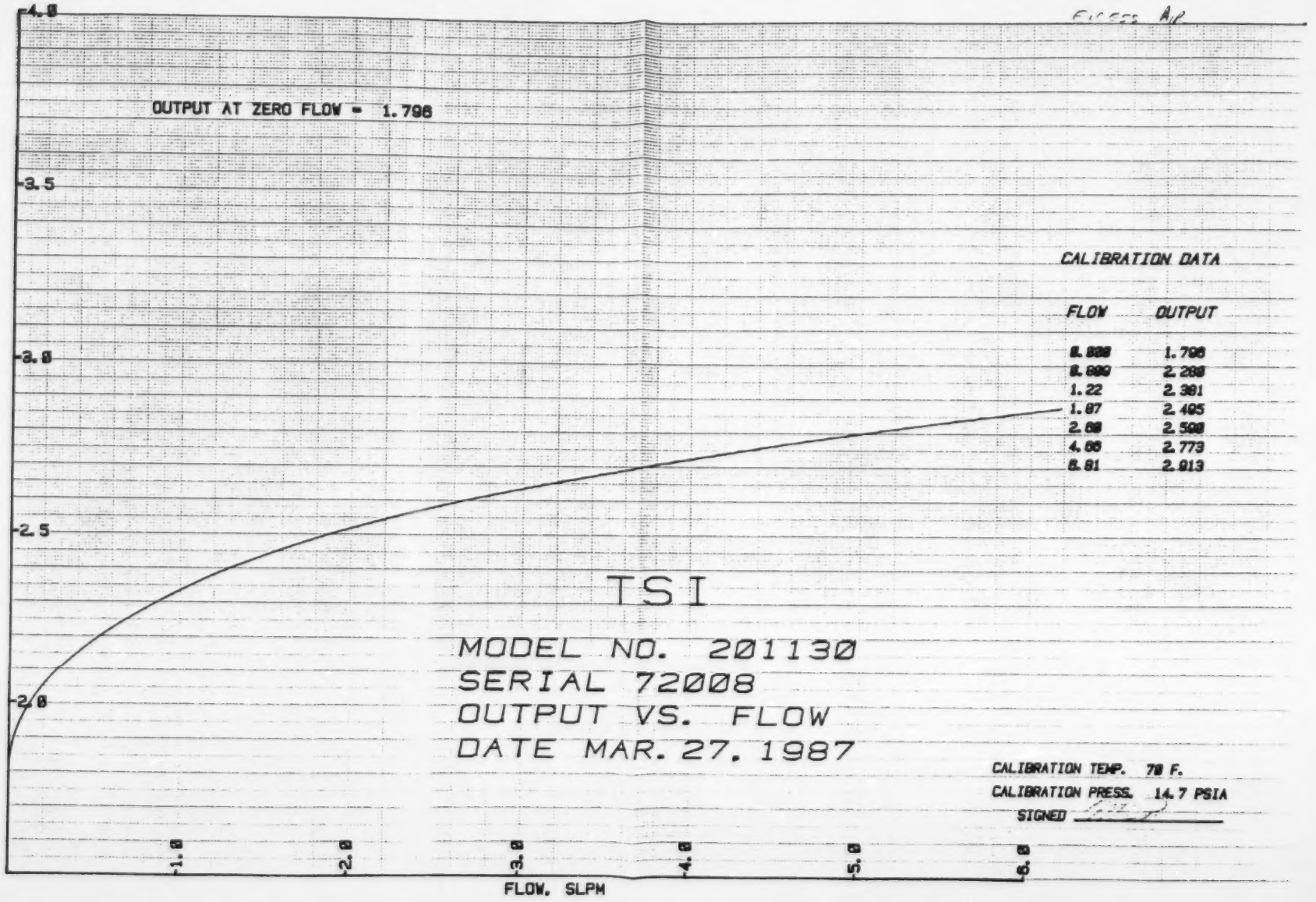

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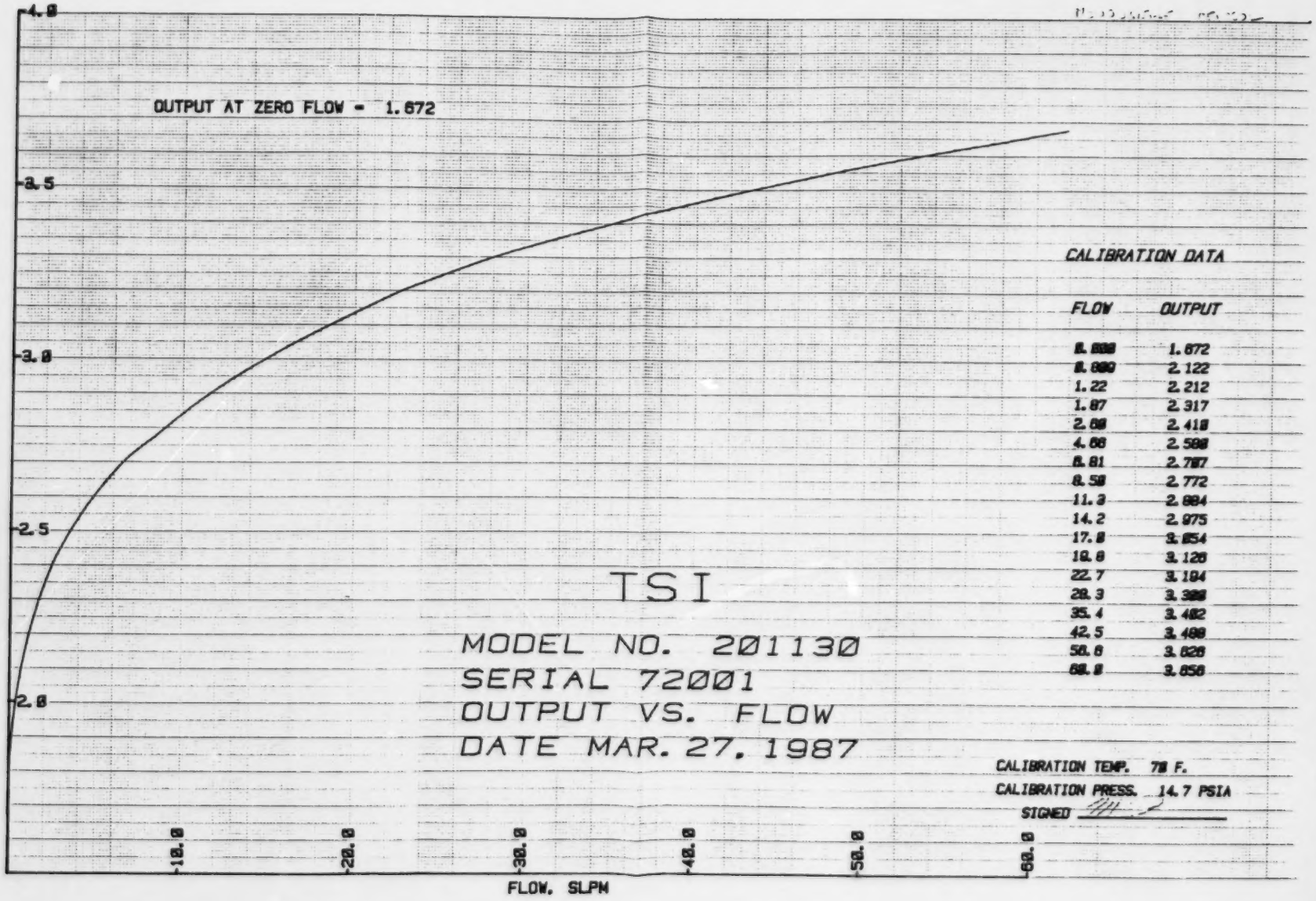
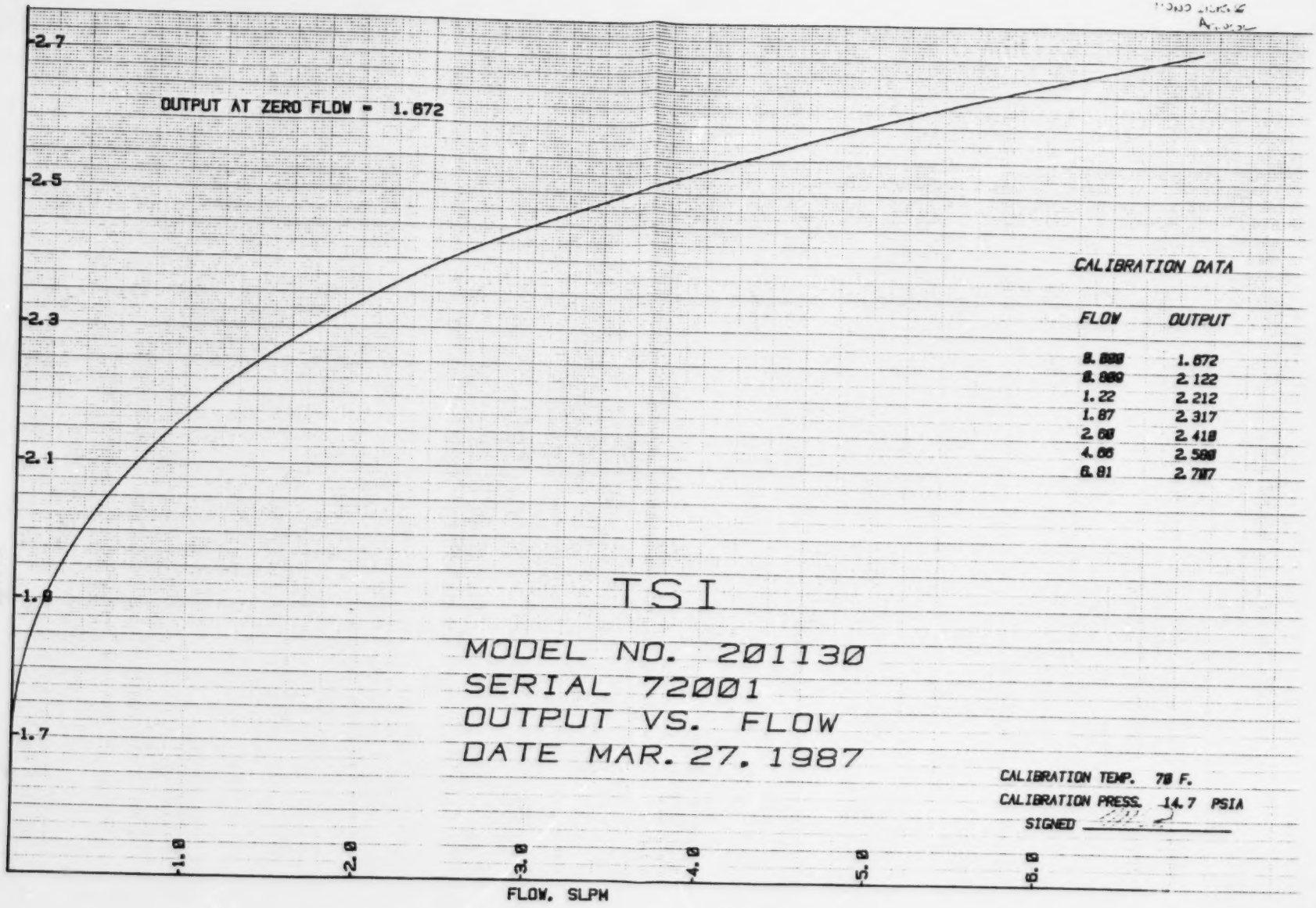

OUTPUT AT ZERO FLOW - 1.672
4.0
3.5
3.0
2.5
2.0
OUTPUT
10.0
20.0
30.0
40.0
50.0
60.0
FLOW, SLPM
TSI
MODEL NO. 201130
SERIAL 72001
OUTPUT VS. FLOW
DATE MAR. 27, 1987
CALIBRATION DATA
FLOW OUTPUT
0.000 1.672
0.680 2.122
1.22 2.212
1.87 2.317
2.68 2.418
4.66 2.588
6.81 2.787
8.58 2.772
11.3 2.884
14.2 2.975
17.8 3.054
18.8 3.128
22.7 3.184
28.3 3.388
35.4 3.482
42.5 3.488
50.6 3.626
60.8 3.656
CALIBRATION TEMP. 78 F.
CALIBRATION PRESS. 14.7 PSIA
SIGNED



47 1510
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91-74

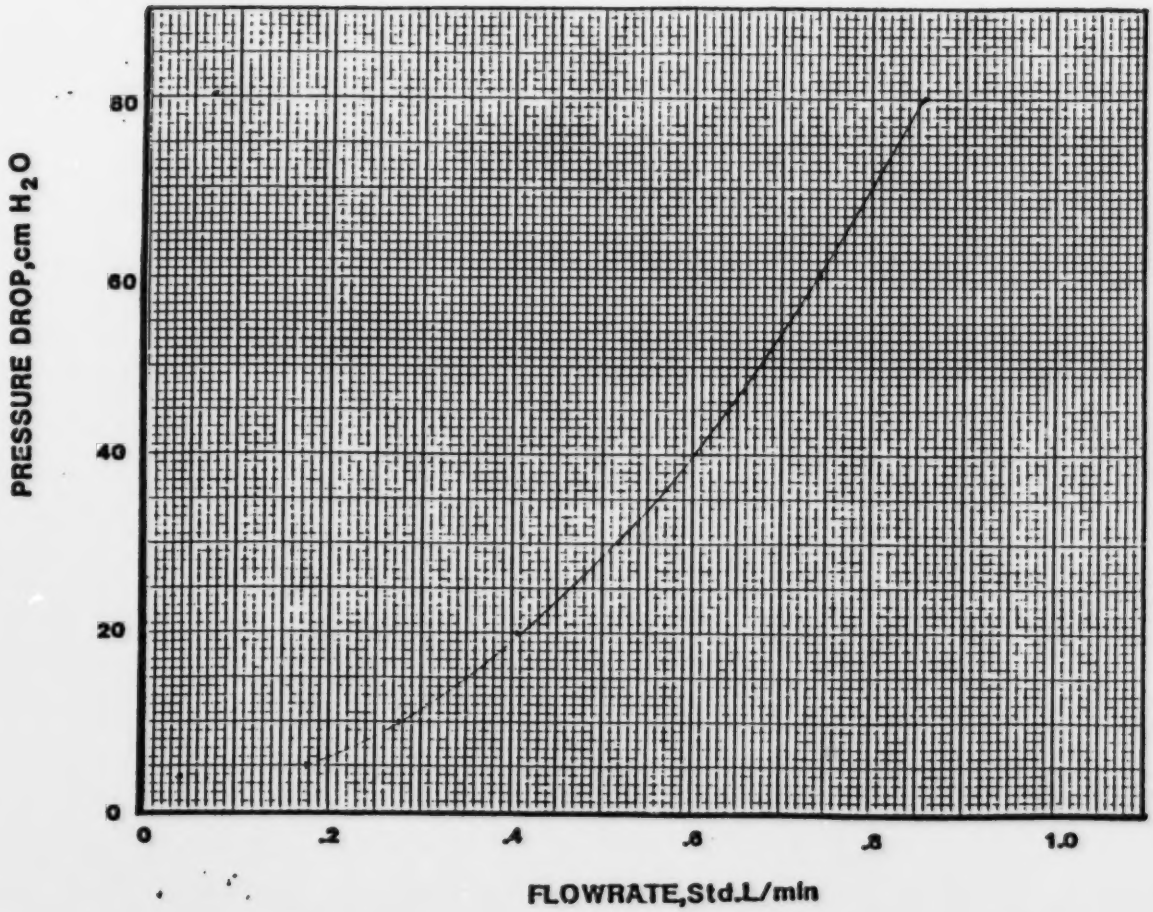
DMPS IMPACTOR FLOW CALIBRATION DATA

PART NO. 1030669

NOZZLE DIAMETER,cm .0457

SERIAL NUMBER 255

Δ P,cm H_2O	FLOWRATE,Std.L/min
5	.178
10	.279
20	.407
30	.516
40	.604
60	.742
80	.859



DATE 7/31/86

NAME RP

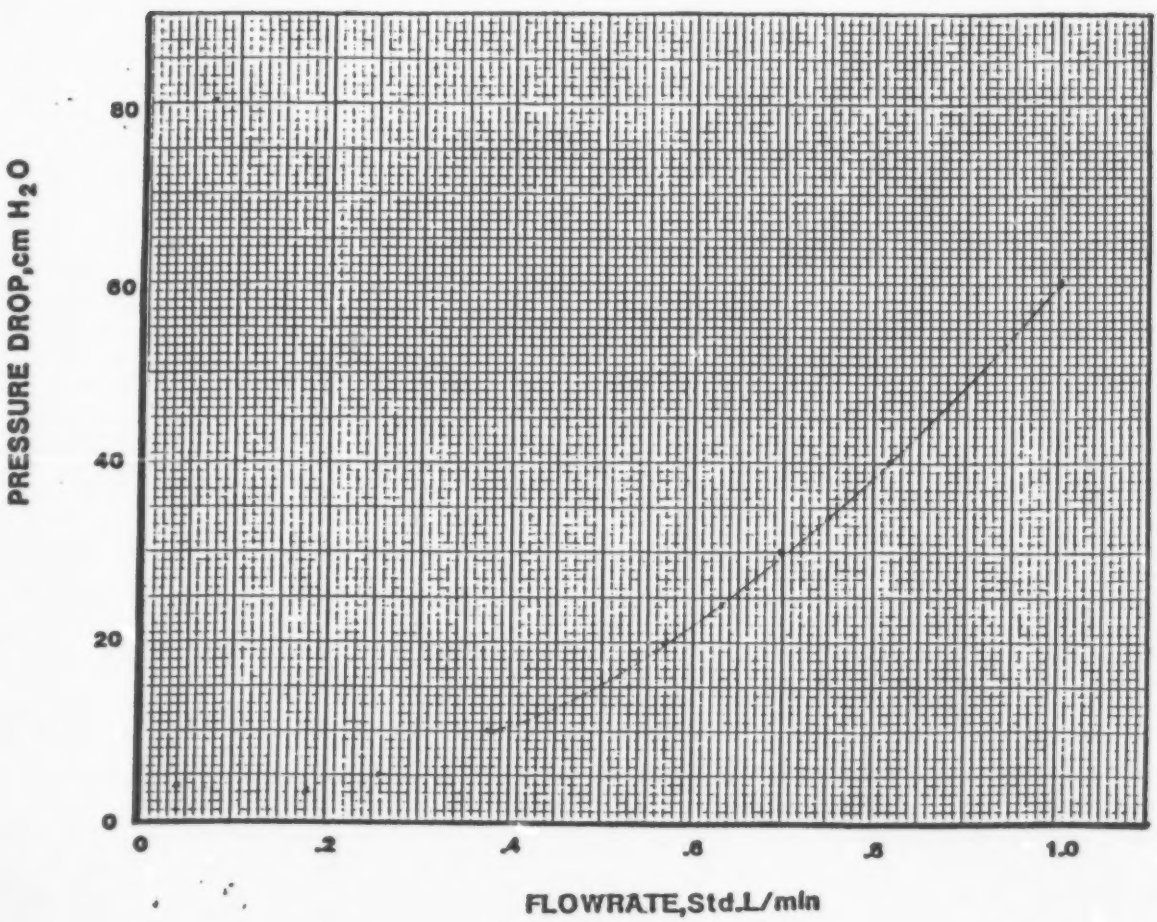
DMPS IMPACTOR FLOW CALIBRATION DATA

PART NO. 1030669

NOZZLE DIAMETER,cm .0508

SERIAL NUMBER 275

Δ P,cm H_2O	FLOWRATE,Std.L/min
3	.180
5	.259
10	.378
20	.570
30	.698
40	.819
60	1.01



DATE 7/31/86

NAME RP

APPENDIX V

NOISE MEASUREMENTS

Research Division
800 Kipling Avenue, Toronto, Ontario, Canada M8Z 5S4

MEMORANDUM

DR. H.M. LEUNG
CHEMICAL RESEARCH DEPT
KD 138

June 22, 1990

825.3(T)

Noise Associated with Room KT125
Aerosol Research Facility

In accordance with your verbal request, we have conducted a brief survey of noise associated with the new Aerosol Research Facility in KT125. Our preliminary findings and recommendations are as follows:

MEASUREMENTS

The 30 HP fan was operated at low, medium and high air flows while noise measurements were made at locations inside KT125 and in adjacent work areas. Most measurements were made with the air filter installed in the duct inlet. A few measurements were repeated with the air filter removed. The measurement locations and test results are shown below.

Location		Max Noise Level-dBA	Noise Spectra
KT125 at operator position			
beside the duct	-fan off	66.8	Figure 1
	-with filter	80.1	Figure 1
	-without filter	88.6*	Figure 2
On duct axis at 4 m from inlet			
	-fan off	62.1	Figure 3
	-with filter	86.5*	Figure 3
	-without filter	98.4*	Figure 4
Fan room	-with filter	90.3*	Figure 5
Work area KT130 adjacent to KT125			
	-fan off	63.0	Figure 6
	-with filter	74.0	Figure 6
Conference room KT115 south			
of KT125	-fan off	51.6	Figure 7
	-with filter	58.6	Figure 7
Work area KT116 south			
of KT125	-fan off	69.5-76.7	Figure 8
	-with filter	72.9	Figure 8

* Mandatory ear protection in excess of 85 dBA.

91-74

Telephone (416) 231-4111 Telex No.: 06-984706 Facsimile (416) 231-9679

CONCLUSIONS

1. Since the noise from the duct inlet did not increase significantly with air velocity (with the filter it was usually a maximum at medium flow) it is concluded that the major noise component is due to fan noise fed backwards through the duct.

2. With the filter removed the noise from the duct inlet increased significantly because the fan noise was no longer attenuated by the filter.

3. The high noise levels in KT125 are readily transmitted to adjacent work areas because KT125 does not yet have a ceiling as previously recommended in our memorandum to Mr. R.G. West.* For example, in the adjacent KT130 work area, the noise level is increased by 11 dB to 74 dBA when the fan is operated with the filter in place. This is well above the 60 dB guideline for this environment.

4. In Conference room KT115 (which has a ceiling) the noise level is increased by 7 dB to 58.6 dBA, which is high for good communication.

5. In the KT115 work area the noise levels are already high, so the 30 HP fan noise is expected to have no significant impact.

RECOMMENDATIONS

1. Install warning signs as required by the Health and Safety Division** for noise levels in excess of 85 dBA.

2. Take steps to reduce the noise in KT125 and adjacent areas, such as installing a silencer on the 30 HP fan intake and treating reflecting surfaces near the duct inlet with acoustic absorptive material.

---

*J.M. Boyd, Noise Treatment for Room KT125 Aerosol Research Facility, Memorandum to R.G. West, February 23, 1989.

**Report HSD-IR-83-1 "Recommended Divisional Noise Control and Hearing Protection Procedures" (Revised Sept 1985).

Detailed recommendations for reducing the noise will require further investigation and noise measurements which we would be glad to discuss with you at your convenience.

J M Boyd

J.M. Boyd
Research Engineer - Vibration
Plant Equipment Dynamics Section
Mechanical Research Department

c: Mr. R.G. West, KA100
Mr. J. Kowalewski

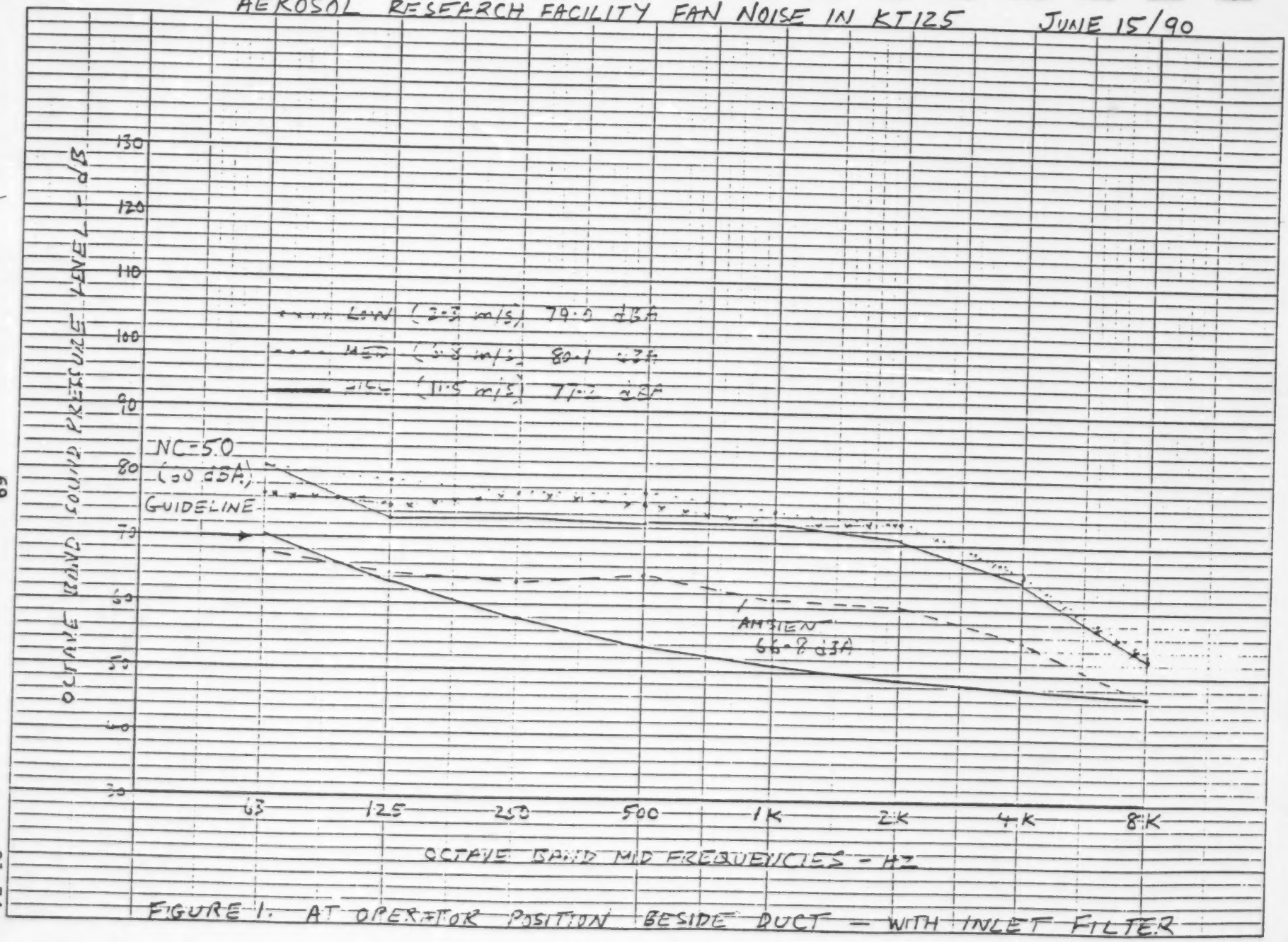


FIGURE 1. AT OPERATOR POSITION BESIDE DUCT — WITH INLET FILTER

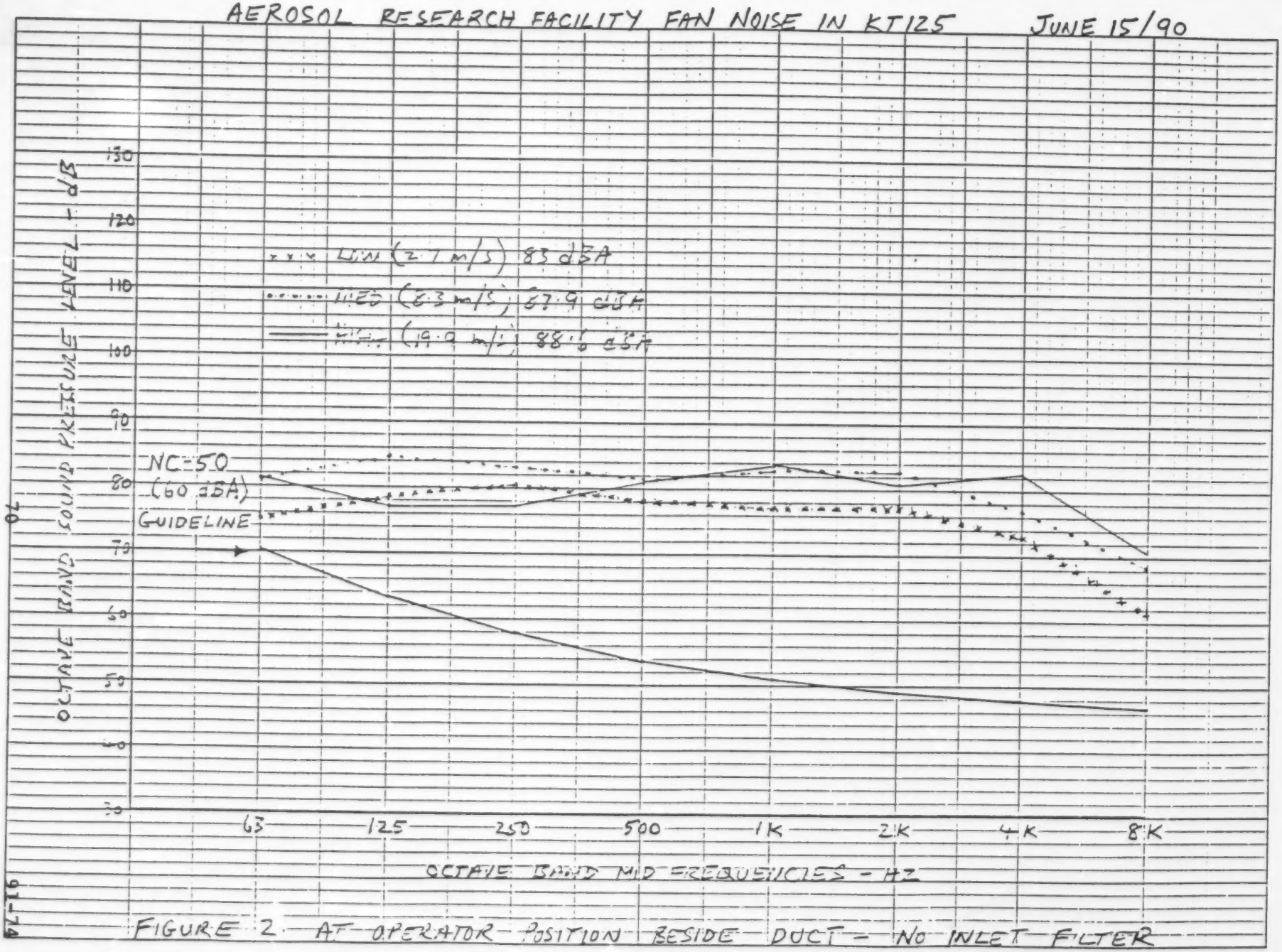


FIGURE 2 AT OPERATOR POSITION BESIDE DUCT - NO INLET FILTER

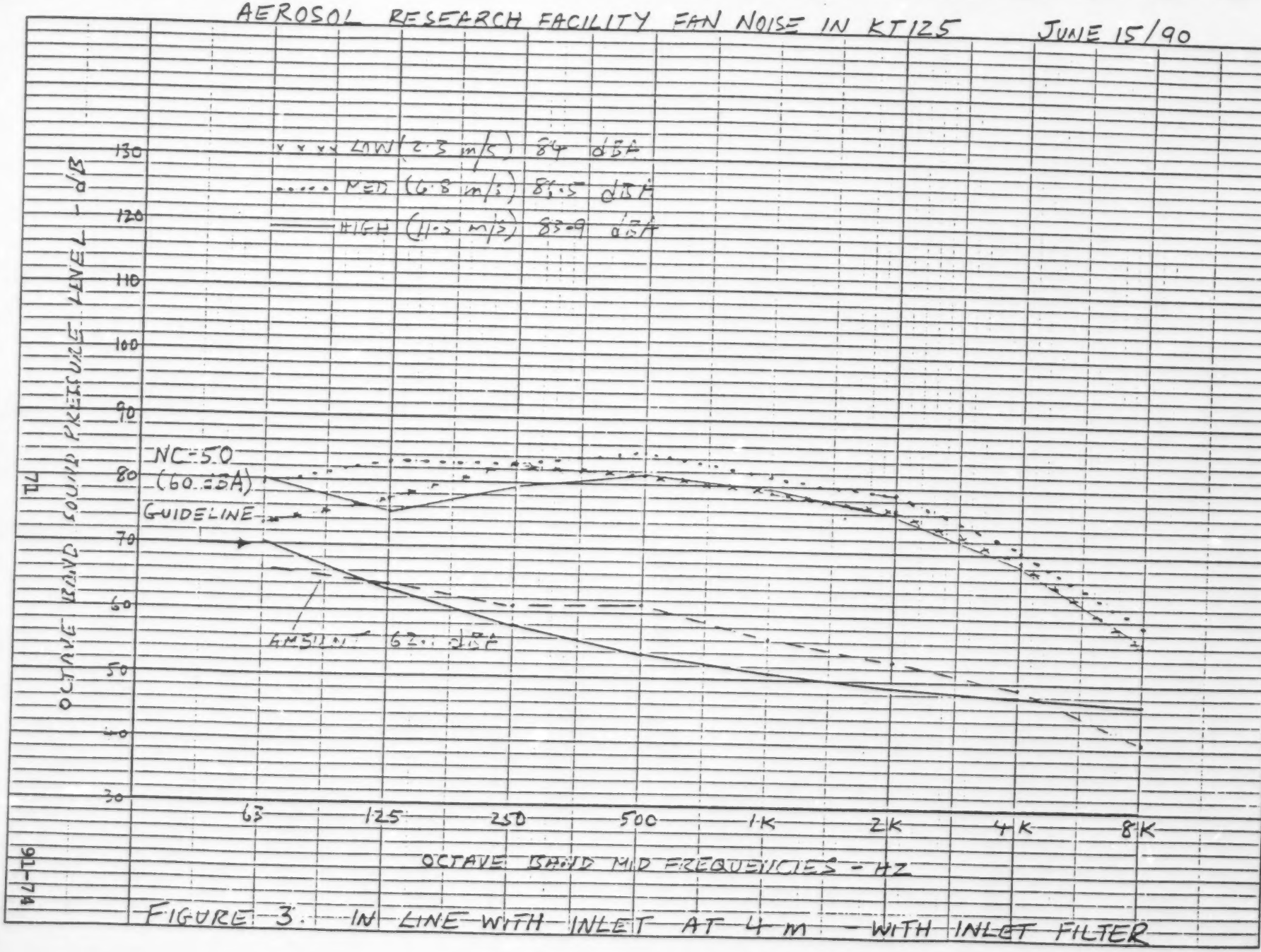


FIGURE 3. IN LINE WITH INLET AT 4 M - WITH INLET FILTER

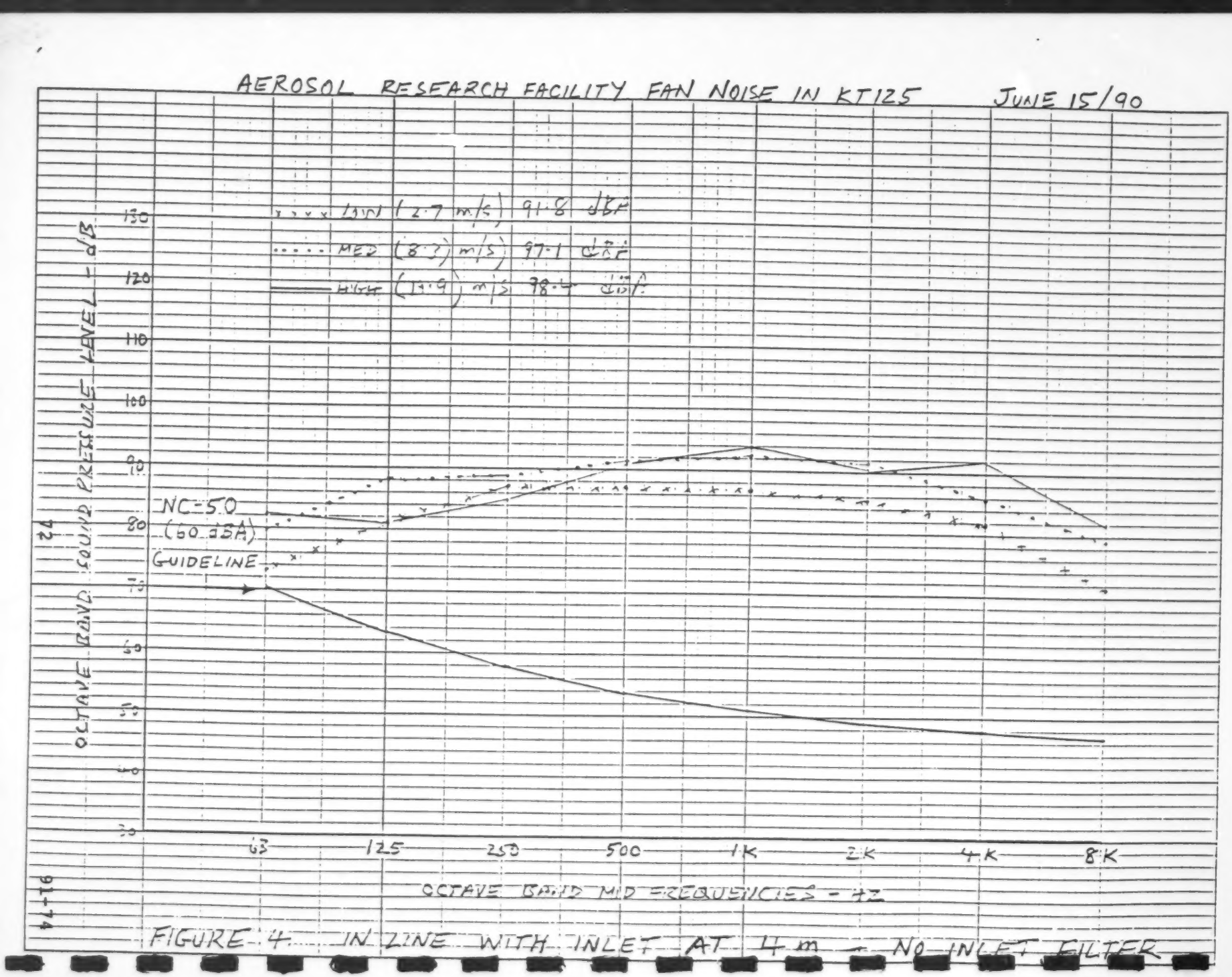


FIGURE 4 IN LINE WITH INLET AT 4 m - NO INLET FILTER

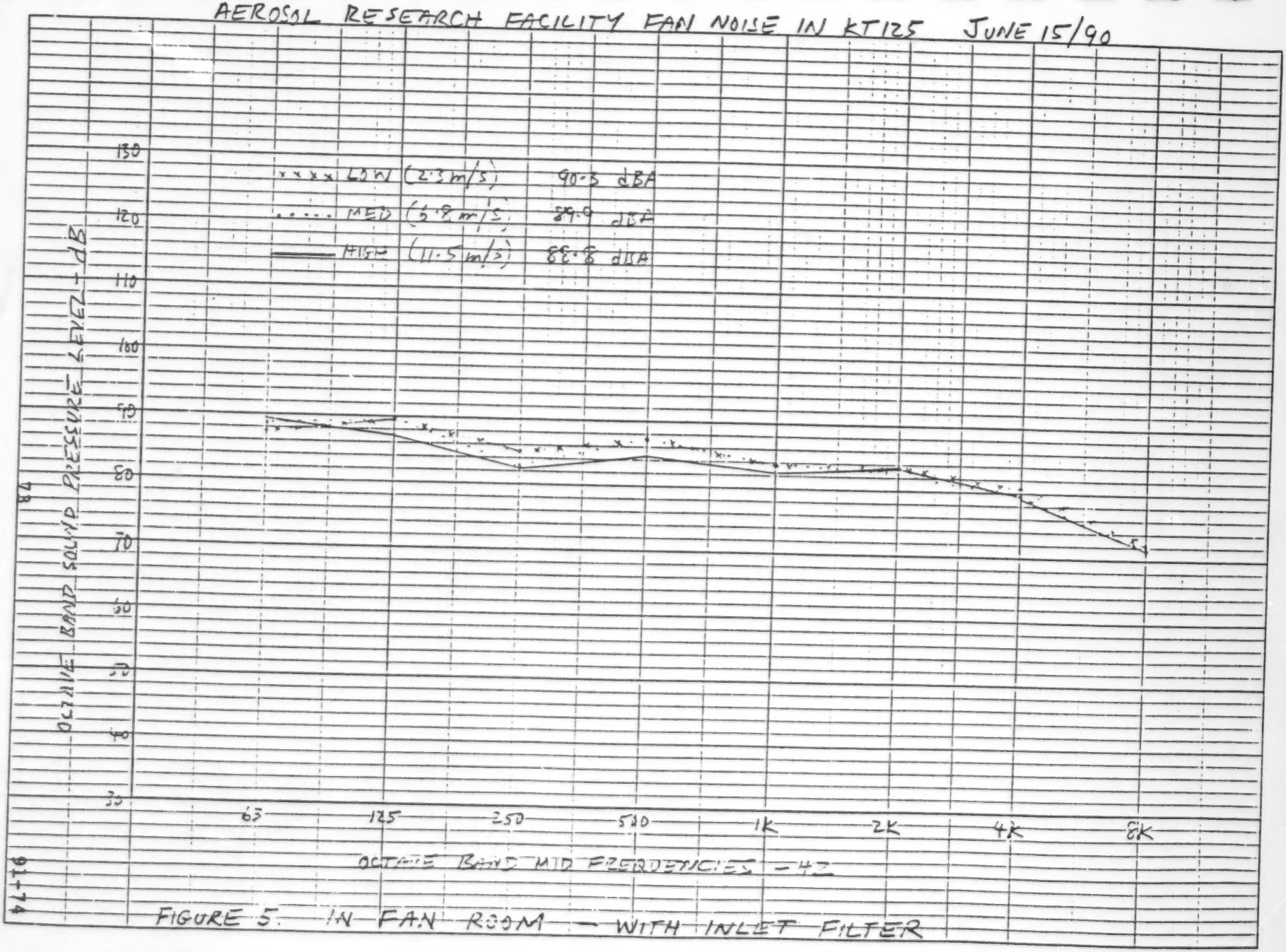


FIGURE 5. IN FAN ROOM — WITH INLET FILTER

AEROSOL RESEARCH FACILITY FAN NOISE IN KT125 JUNE 15/90

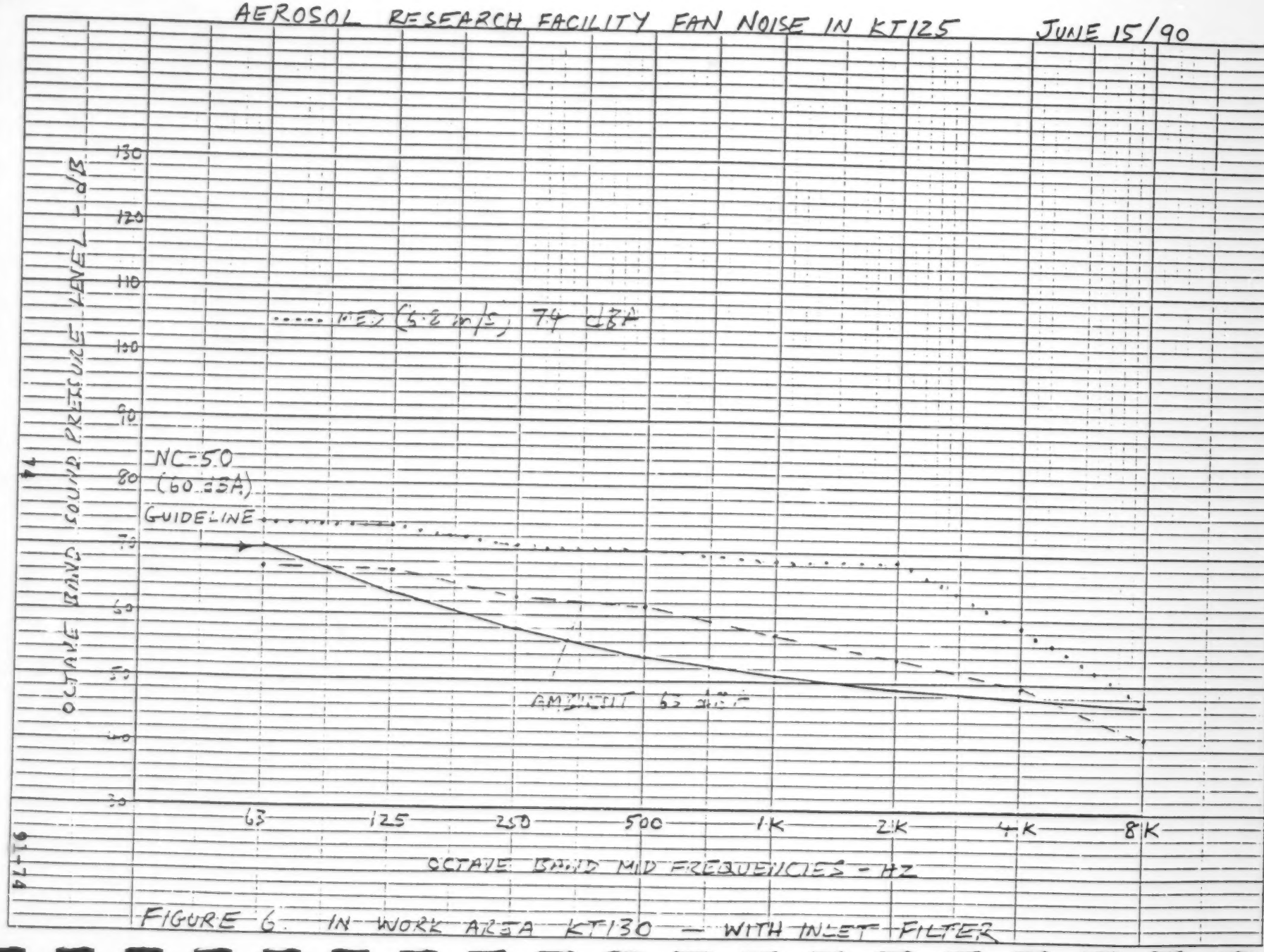


FIGURE 6. IN WORK AREA KT130 — WITH INLET FILTER

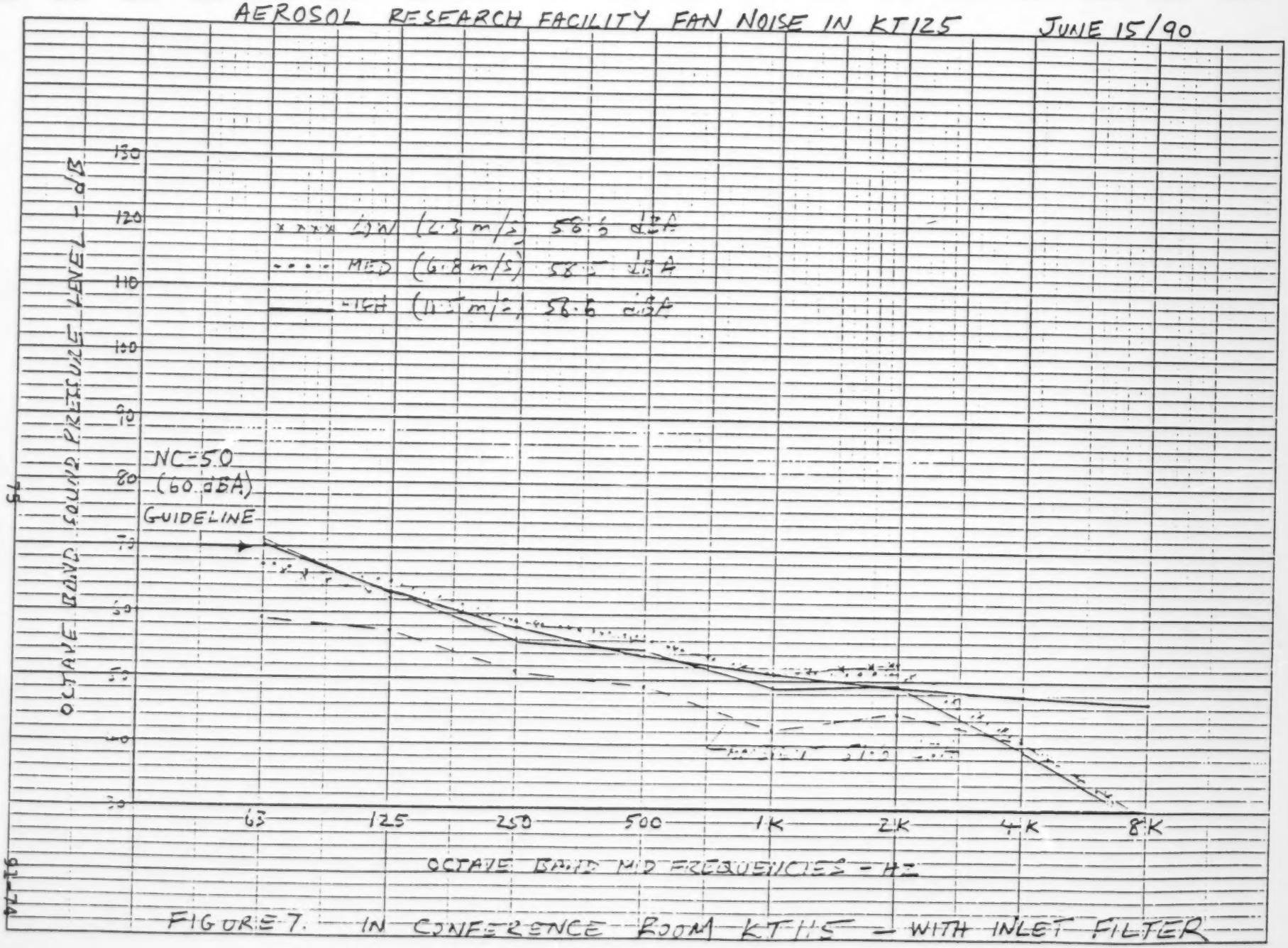
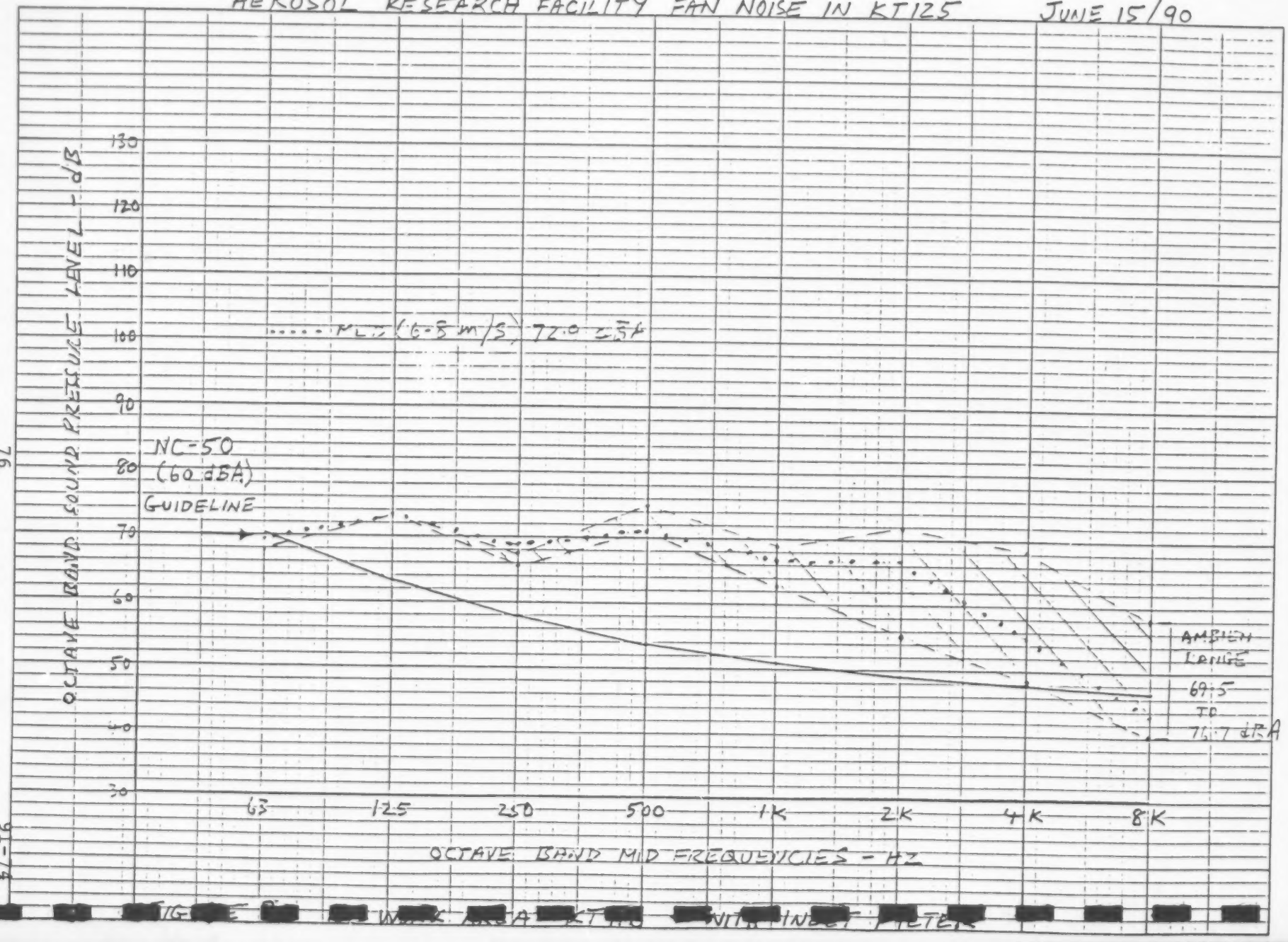


FIGURE 7. IN CONFERENCE ROOM KT115 - WITH INLET FILTER

KEUFFEL & ESSER CO. MADE IN U.S.A.

40 0780

AEROSOL RESEARCH FACILITY FAN NOISE IN KT125 JUNE 15/90



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